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Appreciation

IN an effort to find out how well *Power* is meeting the needs and serving the interest of its subscribers and what can be done to make it more attractive and useful, I sent a number of letters to representative men in different lines. I tried to make it apparent that these were not bids for compliments—that we were not putting up our backs to be patted—that constructive criticism and real suggestion would be appreciated more than simple commendation.

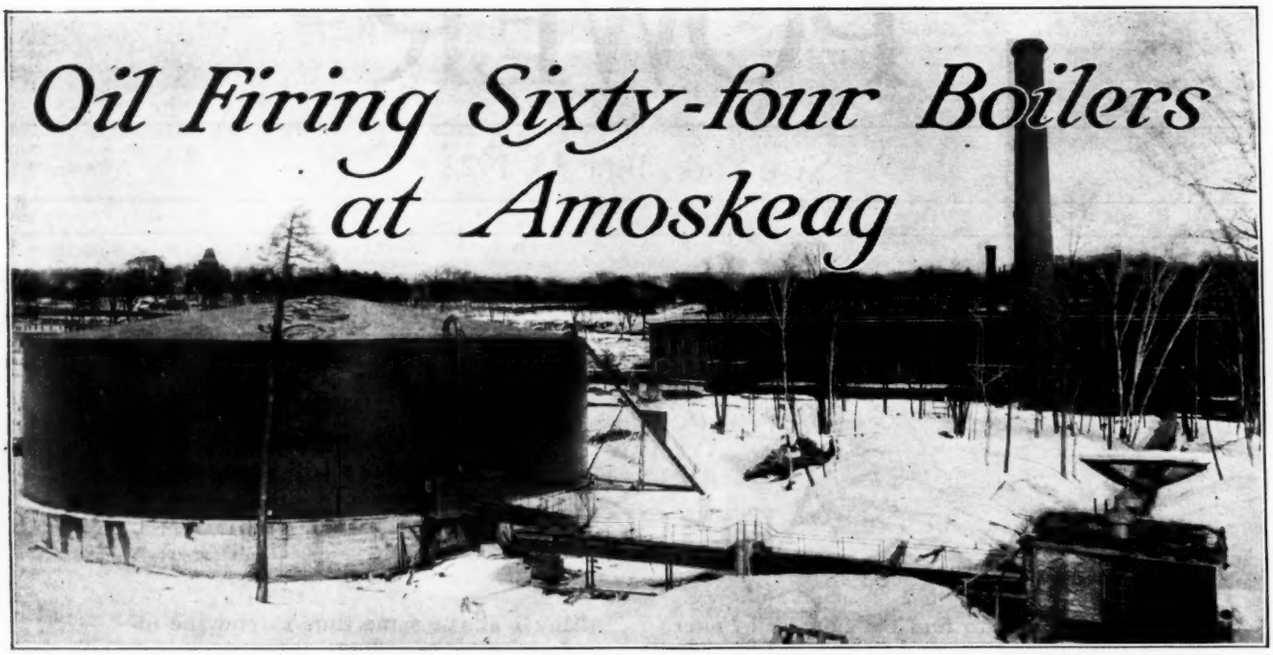
To these letters I have received a surprising and gratifying number of replies, full of kind words for *Power* and often containing suggestions of subjects upon which articles would be acceptable, or as to sources of possible information and as to the manner of its presentation. May I acknowledge in this way the many to which it has been impossible to reply directly, expressing my appreciation of the interest shown and promise to make in our collective interest the best possible use of the ideas presented?

May I at the same time extend the invitation more broadly? If there is any subject upon which you would like to see more articles in *Power*, let us know, and if the subject is connected with power-plant engineering and of sufficiently general interest we will get the articles. If you have any ideas with regard to the method of presentation, they will be thankfully received and given serious consideration. And especially if you have any fault to find with the paper or its editors or management, I want to invite the freest expression of it.

We want to make the best paper that brains and money can put together for power-plant designers, managers and engineers; and the best service that our friends can do us is to tell us in what respects we can better adapt the paper to their own liking.

F. R. Low

Oil Firing Sixty-four Boilers at Amoskeag



AN OIL-BURNING installation that is unique in several respects has recently been completed at the plant of the Amoskeag Manufacturing Co., Manchester, N. H. Sixty-four vertical fire-tube 1,500-sq.ft. boilers of the Manning type are fired by mechanical burners of a special design which permits of group control with negligible stand-by losses. This installation, designed and put in under the supervision of W. G. Diman, superintendent of power, was made primarily to eliminate much of the labor required for coal firing, to get rid of the cinder nuisance—particularly objectionable in a textile plant—and to secure more cleanly boiler-room operation. The oil-burning system, with its centralized control, requires a force of only thirteen men, whereas sixty-one men were needed to operate the plant when the boilers were coal-fired by underfeed stokers.

Two 55,000-barrel Storage Tanks

A plan view of the entire installation is shown in Fig. 1. To provide oil storage two steel tanks, each having a capacity of 55,000 bbl., are set on a cement foundation on an island in the river. Each tank is protected by the usual earthen dike having a capacity one and one-half times that of the tank. The storage was laid out with the idea of furnishing oil in the future to other houses in the plant. A storage of three or four weeks could be maintained at these houses, which would be sufficient when normal shipments were received. In case of a shortage, however, the oil from the 55,000-bbl. main-storage tanks could be used.

Oil is delivered in tank cars on two tracks at the ground level, each track accommodating six cars. In a cement trench placed between the tracks is a 10-in. oil main and a 2-in. steam line. The two are wrapped together in a felt-lined metallic casing so that the steam main aids in keeping the oil main warm in addition to furnishing steam to the tank-car heating coils. The oil main has twelve risers with connections for the unloading hose.

The oil flows by gravity to a 1,000-gal. steam-driven, duplex oil pump placed below the track level in the boiler-room pumphouse (No. 1). The daily eight-hour unloading capacity is twenty-four tank cars of approximately 8,000 gal. each.

This unloading pump discharges into a 10-in. main carrying the oil a distance of about 700 ft. across a bridge to a transfer pumphouse (No. 2) on an island in the river. Here the main is valved to discharge at the top of either storage tank. The pipe is placed inside of an airtight wooden housing the entire distance. This housing is lined with two layers of asbestos board and covered on the outside with tin. It is made in separate pieces which can be removed easily in case of a break in the mains.

Handling Oil from Tanks to Burners

To heat the main-storage oil tanks, two coils are placed in each tank, one for warming the oil flowing to the heating box and one in the heating box. The pipes for the coils are welded into the tank where they pass through from the outside. To protect all outside valves at the tank from freezing, they are enclosed in a small iron house which is kept sufficiently warm by the radiation from the steam pipes supplying the coils.

The 8-in. suction line from each tank runs to the transfer pumphouse (No. 2), where it connects to the suction of three steam-driven duplex slush pumps. These discharge into a 6-in. line which runs to Pumphouse No. 1. There the oil passes through a $\frac{1}{8}$-in. mesh twin strainer and then into the suction of the screw burner pumps. The 6-in. and 10-in. lines are cross-connected at both ends and are fitted with relief valves. In case either line breaks, oil can be delivered through the other. Moreover, if fire should break out in an oil tank, oil can be drawn from the tank that is burning and discharged through the cross-connection into the other.

Pumphouse No. 1 is a fireproof compartment and contains three turbine-driven burner pumps. The discharge from these passes into either of two five-pass heaters controlled by thermostats. In case the oil is heavy, both heaters can be used if necessary. The oil from the heaters discharges into a 4-in. main and

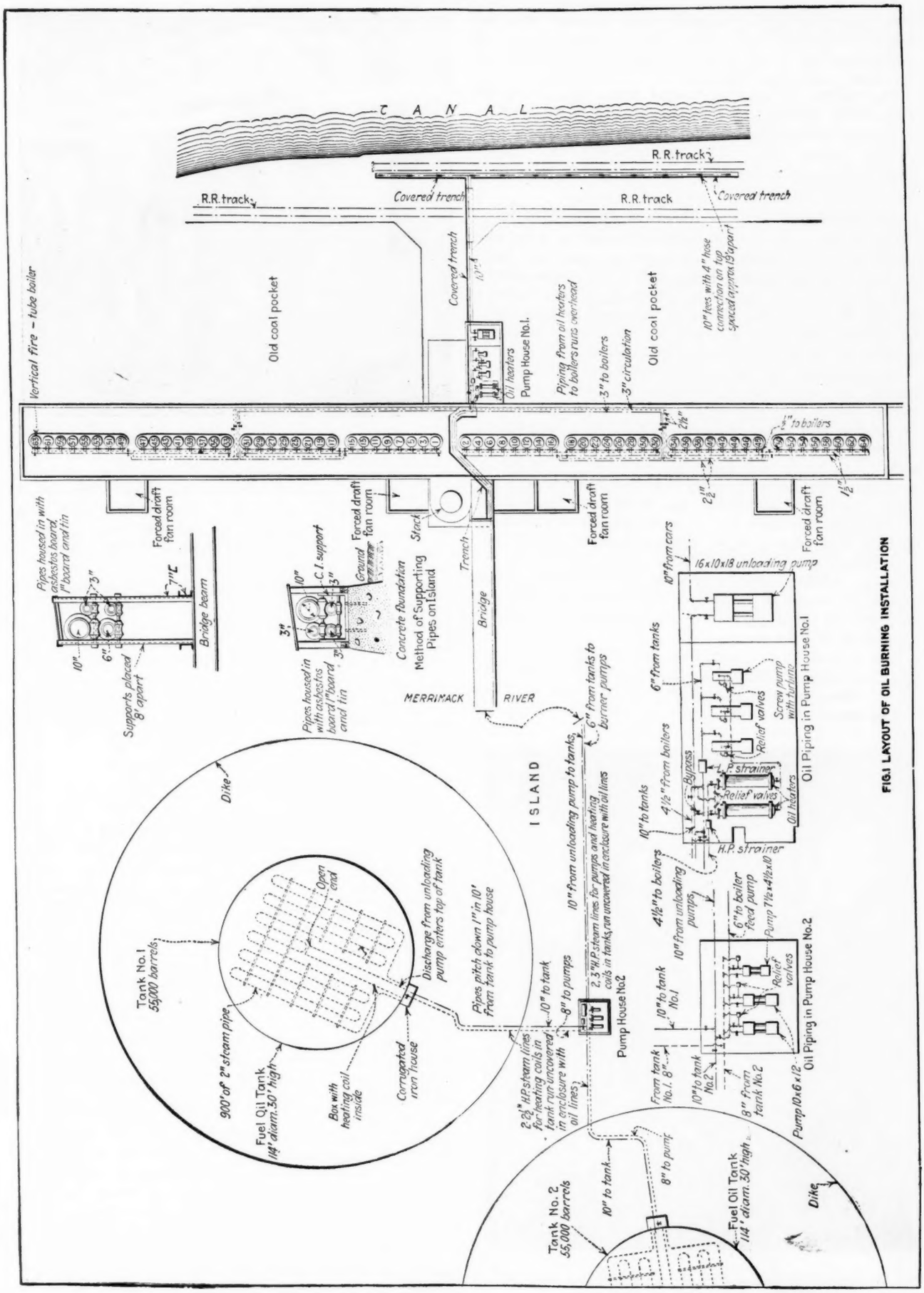


FIG.1 LAYOUT OF OIL BURNING INSTALLATION

then goes through a 20-mesh twin strainer into the common delivery line. The exhaust steam from all pumps and the drips from all heaters are returned to the main feed-water heaters.

The boilers in this particular boiler house are set in one line and divided into batteries of eight, making the length of the house about 500 ft. Fig. 2 shows half of the boiler house with 32 boilers. The 200-ft. chimney (12 ft. diameter) is in the center with four batteries on each side

Oil Piped to Give Same Pressure at All Boilers

Oil is distributed to the boilers through a 3-in. line which runs a distance of two batteries each way from the center of the house. From each of these two points the oil is fed both ways for a distance of one battery through a 2½-in. line. Here it branches to feed eight boilers on each side. The idea of this piping arrangement is to have the pressure equalized at each burner.

At the center of the boiler house 3-in. cutout valves control the supply of oil to each side. There are also cutout valves that control the branches to the groups of sixteen and eight boilers. With this arrangement one boiler, eight, sixteen, thirty-two or even sixty-four boilers can be cut out from service when not required or when a breakdown occurs. The return lines parallel the delivery lines and are of the same size. Valves are in the same relative position as on the delivery line, so that the load on one, eight, sixteen, thirty-two or sixty-four boilers can be easily controlled.

Direct-reading and recording thermometers and gages are placed at various control points so that the delivery and return pressures and temperatures can be easily regulated.

The control for two batteries (eight boilers each) is shown in Fig. 3. The gage *D* indicates the pressure in the 2½-in. supply main, which is in back of the return main. The temperature in the return main is

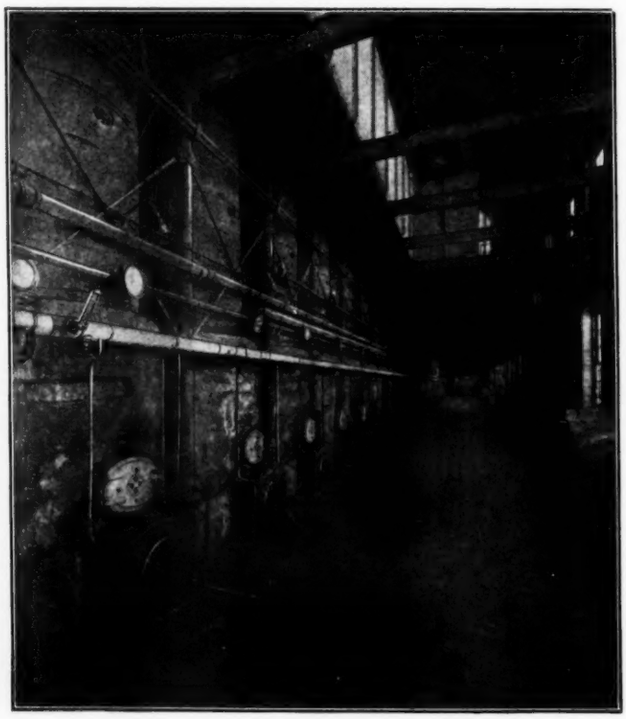


FIG. 2. ONE-HALF OF BOILER ROOM, SHOWING 32 OF THE 64 VERTICAL FIRE-TUBE BOILERS

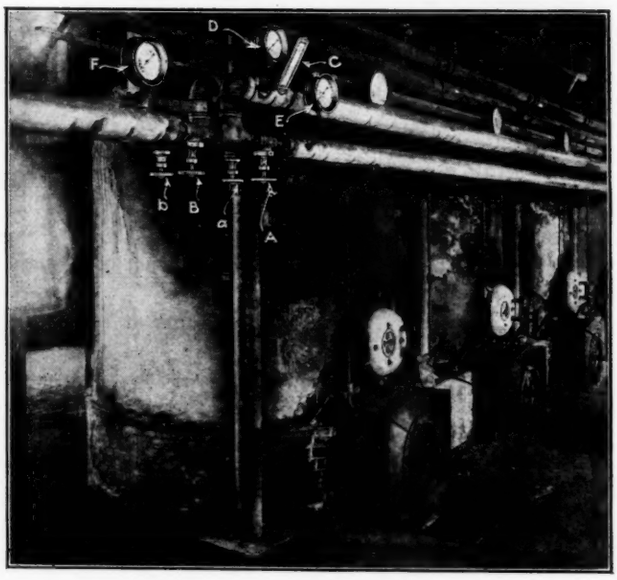


FIG. 3. CONTROL POINT FOR TWO BATTERIES OF EIGHT BOILERS

shown by the thermometer *C*. The 1½-in. valves at *A* and *B* control the return-line oil from the right and left batteries respectively. Gage *E* measures the pressure in the return of the right-hand battery while *F* does the same for the left-hand battery.

The supply lines are directly behind the return lines just mentioned, valves *a* and *b* in the supply lines corresponding to *A* and *B* in the return lines. Valves *a* and *b* are left open during ordinary operation. By means of *A* and *B* the load on the boilers of each battery can be regulated by varying the return-line pressures.

The pipe sizes were figured to give a maximum velocity of not over 100 ft. per min. All the piping and fittings are extra-heavy.

Simple Method of Control

This installation is designed to have all boilers, with the exception of sixteen, operate at a steady load. To accomplish the variation, use is made of a damper regulator operated by the steam pressure. Two valves are controlled by the damper regulator, one a steam bypass to the fan engine and the other the burner bypass valve. This arrangement increases the air supply before increasing the amount of oil fed to the furnace, and decreases the oil in the furnace before the air supply is decreased.

When the steam pressure drops, the piston rod of the damper regulator moves up and opens the steam valve on the fan engine bypass, thus supplying more steam to the fan engine. The piston rod continues up until it closes the bypass valve on the burner return line.

One of the Peabody-Fisher wide-range oil burners used in this plant is shown in Fig. 4. This is designed to give greater flexibility than is obtainable with ordinary types of mechanical burners. The atomizing effect is produced, as in other types, by the centrifugal force of a rapidly rotating jet leaving an orifice. In any case the velocity of rotation, and hence the completeness of atomization, depends on the amount of oil flowing *into the burner*. The burner here described has a full and constant flow of oil into the chamber of the burner no matter what the load. This oil, entering through the tangential slot *A*, is thus given a rotary

motion. The burner is regulated entirely by the bypass connection at *C*. Opening this reduces the amount of oil passing through the orifice into the furnace. In this way it is possible to regulate the flow of oil through the orifice without appreciably affecting the atomization. This permits boilers to be kept in readiness under pressure with a very low flame. It also makes it possible to start the boilers up gradually and thus reduce expansion strains.

With this type of burner any number of individual burners may be installed with their return or bypass pipes connected to a common return header. The whole group may then be controlled by a single master valve in the return main. This type of control is used in the Amoskeag plant, and the arrangement of piping, valves, etc., has already been described. It will be remembered that the return piping, as well as the supply piping, is laid out with successive branches, and that master valves, located at the various branches of the return system, control the boilers in groups of eight, sixteen, thirty-two or sixty-four.

Plant Easily Changed to Coal if Desired

One idea kept in mind in connection with the burner installation was to make it easy to change from oil to coal or the reverse. To do this the burner was set as shown in Fig. 5. The windbox surrounding the air register was made with a forced-draft damper at the bottom and natural-draft dampers at the sides. The retort as well as the dead plates were removed from the Jones underfeed stoker and the furnace was lined up with one course of 6-in. cupola firebrick extending two courses above the mud ring. The firebrick was backed up with asbestos, and the courses above the mud ring were made easily removable to provide for staybolt repairs.

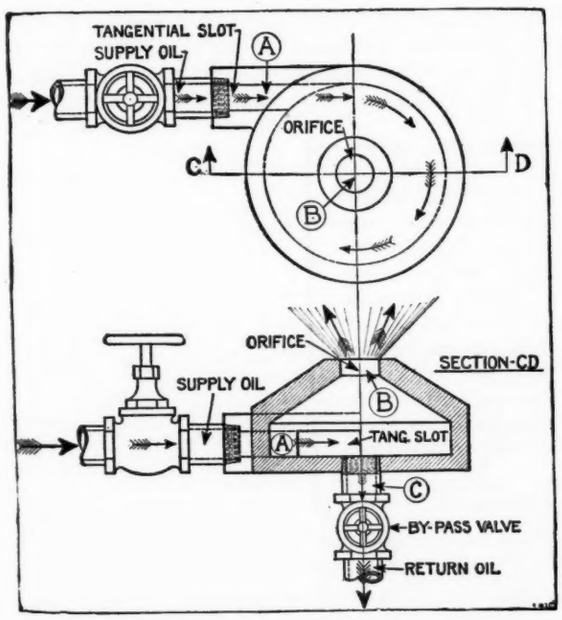


FIG. 4. TYPE OF OIL BURNER USED

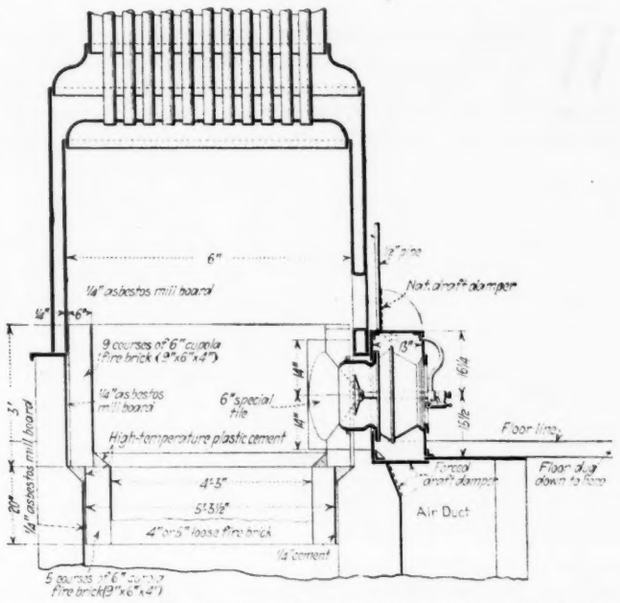


FIG. 5. METHOD OF INSTALLING OIL BURNERS IN THE BOILERS

The bottom of the furnace is covered with a cheaper grade of firebrick. To furnish air for the stokers an air duct ran in front of the boilers. The windboxes of the oil-burning installation are connected to this. The mixing chamber is fitted into the furnace brickwork, the windbox being held to the brickwork with hook bolts, and the air register is placed in the windbox.

The intention with this installation was not to increase greatly the load on the individual boilers. The tips were figured to give a maximum oil supply of 500 lb. an hour or about 130 per cent of boiler rating. This will not decrease the life of the boilers and will at the same time be less severe on the brickwork.

Oil in the main storage tanks is measured by Pneumercators, one of which is fitted to each tank with the scale situated in the transfer pumphouse. This scale gives the specific gravity as well as the weight and height of the oil.

The installation was designed to give a maximum load of 14,000 kw. with sixty boilers operating. The plant has been in operation for about four months and during this time has given entire satisfaction.

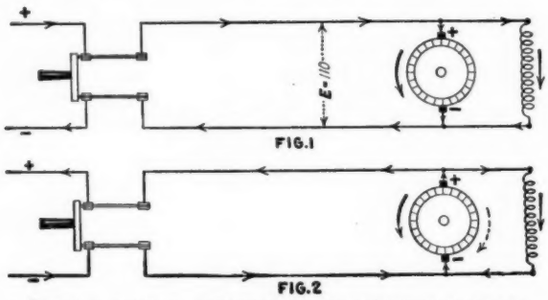
TABLE OF PRINCIPAL EQUIPMENT IN AMOSKEAG OIL-BURNING INSTALLATION

No.	Equipment	Kind	Size	Use	Maker
64	Boilers	Manning	1,500 sq.ft.	Furnish steam for textile plant	Amoskeag & Dillon
64	Oil burners	Wide range, mechanical atomization		One on each boiler	Peabody Engineering Corp.
2	Oil tanks	Steel	55,000 bbl.	Storage	Lancaster Iron Works
1	Oil pump	Duplex steam-operated slush pump	1,000 gal.	Oil transfer	Epping-Carpenter Pump Co.
2	Oil pumps	Duplex steam-operated slush pump	80 gal.	Oil transfer	Worthington Pump & Machinery Corp.
1	Oil pump	Duplex steam-operated slush pump	20 gal.	Oil transfer	Worthington Pump & Machinery Corp.
2	Oil pumps	Screw	80 gal.	Furnish oil to burners	Quimby Co.
1	Oil strainer	Twin, low pressure	¼-in. mesh		Elliott Co.
1	Oil strainer	Twin, high pressure	20-mesh		Elliott Co.
2	Oil heaters	5 pass	100-gal.	Heating oil	Griscom-Russell Co.

Regenerative and Dynamic Braking with Direct-Current Motors

By B. A. BRIGGS

WHEN a direct-current motor is operating at normal speed and voltage, there is generated in the armature an electromotive force almost equal to the line volts. This voltage opposes that of the line and for that reason is called a counter-electromotive force or counter-voltage. If power is applied to the armature shaft and it is driven faster than normal speed, the counter-voltage will become higher than the line volts, causing the machine to become a generator and supply current back into the system. This will be more readily understood by referring to Figs. 1 and 2.



FIGS. 1 AND 2. DIAGRAMS OF SHUNT MOTOR

Fig. 1—Indicates direction of current when machine is operating as a motor. Fig. 2—Indicates direction of current during regenerative braking periods.

DIRECT-current motors may be made to develop a braking action under two conditions—one when the load drives the armature above normal speed; secondly when the motor is disconnected from the line and its armature circuit is closed through a resistance. The first is called regenerative braking and the latter dynamic braking. This article explains how the actions take place and how they are applied in the operation of direct-current elevator motors.

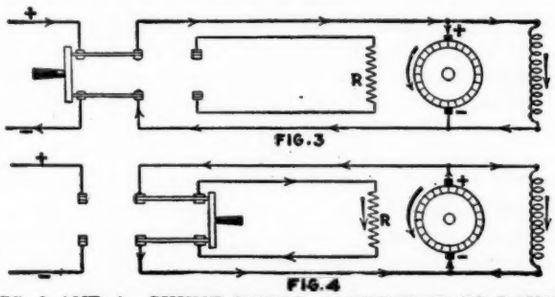
In Fig. 1 consider a shunt motor connected to a 110-volt circuit and operating under normal conditions at 1,200 r.p.m. Assume that under these conditions the counter-electromotive force is 105 volts; that is, the 110-volt line pressure is causing a current to flow through the armature from the + to the — brush, while in the armature winding there is generated 105 volts which tends to cause the current to flow from the — to the + brush. This leaves an effective voltage of 110 — 105 = 5 to cause the current to flow through the armature and drive the machine as a motor. Of course the counter-voltage must always be less than the line volts if the machine is to operate as a motor.

Now assume that power is applied to the motor's shaft and its speed is increased to 1,300 r.p.m. Then if the line volts remain constant and the counter-voltage increases as the speed, at 1,300 r.p.m. this voltage will equal $\frac{1,300 \times 105}{1,200} = 114$ volts. Under this condition the counter-e.m.f. is higher than that of the line by 4 volts, and current will flow from the + brush of the motor to line; that is, the motor has become a generator. This condition is indicated in Fig. 2, where the current is shown flowing through the armature in the reverse direction from that in Fig. 1. Assume that in Fig. 1, with the current flowing from the + to the — brush, the armature is caused to revolve in the direction of the curved arrow. Now, with the armature driven above normal speed from some outside source, as assumed in Fig. 2, the current is reversed, consequently will tend to produce a reversed direction of rotation. Although the source of mechanical power drives the armature in the direction of the full-line curved arrow, the current tends to turn it in the reverse direction indicated by the dotted curved arrow. In other words, the current in the armature produces a counter-torque and causes the armature to act as a brake, and this is what is called regenerative braking.

This is the condition that exists in an elevator motor when a heavy load is being lowered in the car. The load tends to overspeed the motor, but before the speed has very materially increased, the motor becomes a generator and delivers current into the line. This current is of a direction in the armature windings to oppose rotation, causing the motor to act as a brake, and prevents the car from overspeeding, consequently the car will run at about the same speed on the down motion loaded as it does in the up motion.

Assume that the motor Fig. 1 is connected to a double-throw switch as in Fig. 3, with the right-hand clips connected to a resistance *R*. Further, assume that in Fig. 3 normally the same conditions exist in the motor as assumed for Fig. 1. Now if the switch is thrown over so as to connect the motor to resistance *R*, as in Fig. 4, line voltage is cut out from the motor, but the counter-voltage is still effective in the armature.

As soon as the switch is close to *R*, the counter-voltage causes a current to flow in the circuit, as indicated by the arrowheads. This current is in a direction through the armature to produce a counter-

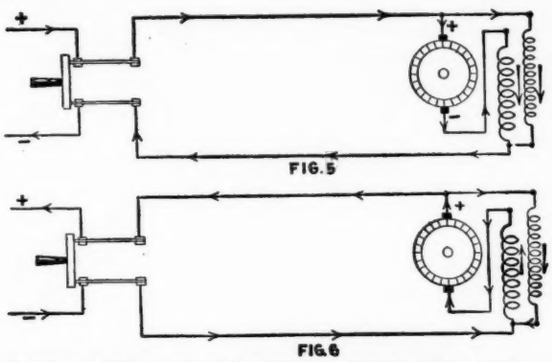


FIGS. 3 AND 4. SHUNT MOTOR CONNECTED TO DOUBLE-THROW SWITCH

Fig. 3—Motor connected to line. Fig. 4—Motor connected to resistance for dynamic braking.

torque, which acts as a brake and assists in bringing the motor and its load to rest. Connecting a motor through a resistance so that it can become a generator during the stopping period and assist in bringing the motor and its load to rest is called dynamic braking. From the foregoing it is seen that regenerative braking is when a motor is converted into a generator and acts as a brake to prevent its load from overspeeding by supplying power into the line. Dynamic braking takes place when a motor is disconnected from the line and connected to a resistance and made to act as a generator to assist in bringing the load to rest. Most all modern direct-current elevator controllers are equipped for dynamic braking. The connections are so arranged that when the contactors open and cut the power out of the motor, they automatically close the motor's armature circuit through a resistance, which causes the motor to act as a brake and assists the mechanical brake to bring the car to rest.

The extent to which the motors will act as a brake—



FIGS. 5 AND 6. DIAGRAMS OF COMPOUND MOTOR
Fig. 5—Indicates direction of current when machine is operating as a motor. Fig. 6—Indicates direction of current during regenerative or dynamic breaking periods.

in other words, the effectiveness of the dynamic braking—is controlled by the value of the resistance connected across the motor's terminals. The lower the resistance the higher the current and the stronger the braking action. This resistance is generally adjusted so that about the normal full-load current will flow through the resistance when the motor is first connected, the current decreasing as the motors slow down.

Where compound motors are used, as is general practice in elevator work, the series winding must be cut out so that the motor will act effectively during both regenerative braking and dynamic braking periods. Considering Fig. 5 operating as a compound motor, it will be seen that the currents in both field windings are in the same direction. Now if this motor were to be overspeeded, it would act as a generator and supply current to the line, as in Fig. 6. Following out the circuits shows that the current reverses not only in the armature, but also in the series winding. This puts the two field windings in opposition, consequently will weaken the magnetic field in the polepieces, which will allow the load to drive the motor at a much higher speed than normal and in some cases will cause racing. For example, if an electric elevator races on the down motion, it will generally be found that the motor series winding is not being cut out of circuit after the machine has been started. As pointed out in the foregoing, it is for this reason that the series winding of a compound motor is cut out of a circuit after the machine has come up to speed.

Standard Specifications for Power Piping*

General Requirements and Material

In the absence of a distinct specification by the purchaser for material of different grade, all material furnished shall conform to these specifications.

All castings shall be smooth and free from injurious defects.

The metal in steel castings shall conform to the requirements of the American Society for Testing Materials for "Medium Castings."

The metal in semi-steel castings shall have a tensile strength of not less than 30,000 lb. per sq.in. A transverse test of the "Arbitration Bar" as outlined by the American Society for Testing Materials, supported 12 in. between centers shall show before breaking a load of 3,300 lb. and a deflection of not less than 0.12 inch.

The metal in gray-iron castings shall have a tensile strength of not less than 20,000 lb. per sq.in. A transverse test as for semi-steel shall show before breaking a load of 2,900 lb. and a deflection of 0.10 inch.

Dimensions of Flanged Fittings

All standard and extra-heavy flanged fittings shall conform to the center to face, thickness and flange dimensions of the "American Standard" as recommended in 1914 by the A. S. M. E. Fittings used for working steam pressures 25 lb. and lower, and for water pressures 50 lb. and lower, may be lighter in the shell than the American Standard for 125 lb. working pressure.

Drilling and Facing of Flanges

All drilling of flanges shall conform to the templets of the said "American Standard" and shall straddle centers.

Standard flanges shall be plain faced. Extra-heavy flanges shall have raised face extending to the inside edges of bolt holes.

All bolt holes in the flanges of cast-steel material; extra-heavy cast-iron or semi-steel material, 14 in. and larger; and standard material 24 in. and larger, shall be spotfaced. Backfacing of flanges shall be considered the equivalent of spotfacing.

Type of Joints

The following sizes are the smallest for which flanged joints will be required except for unions. Below these sizes screwed connections may be used.

	Inch
Superheated steam	2
Saturated steam above 125 lb.	2½
Boiler feed	2½
Exhaust	2½
Low-pressure water	2½
Blowoff	2
Drains	2½

Gate, Globe and Angle Valves

Gate valves shall be used except where their function is that of throttling; or for sizes smaller than 1½-in. for superheated steam, or ¾-in. for saturated steam, in which case they shall be either globe or angle valves.

All outside screw gate valves shall be backseated to provide for repacking under pressure.

*Adopted by the Power Piping Society June 24, 1915; revised Jan. 27, 1922.

Materials and test pressures for the various services shall be as follows:

Superheated steam—Gate valves 2-in. and larger shall be extra-heavy, outside screw and yoke pattern, with cast-steel bodies, bonnets, discs and yokes; monel metal or 23 per cent nickel-steel seats and disc rings; monel metal or 23 per cent nickel-steel stems; and monel metal or 23 per cent nickel-steel backseating bushings below the stuffing boxes. Valves 8-in. and larger shall be bypassed.

Globe and angle valves 2-in. and larger shall conform to the same general specification.

All valves 1½-in. and smaller shall be extra-heavy and shall be made of bronze containing not less than 10 per cent of nickel, cast steel monel mounted or drop-forged steel monel mounted.

Valves shall be tested to 800 lb. hydrostatic pressure.

Saturated Steam Between 150 and 250 Lb. per Square Inch Inclusive—Gate valves 2½-in. and larger shall be extra-heavy outside screw and yoke pattern, with semi-steel bodies, bonnets, discs and yokes; bronze seats and disc rings; and bronze stems. Gate valves 8-in. and larger shall be bypassed.

Globe and angle valves 2½-in. and larger shall conform to the same general specification.

All valves 2-in. and smaller shall be extra-heavy bronze.

Valves shall be tested to 800 lb. hydrostatic pressure.

Saturated Steam Between 125 and 149 Lb. per Square Inch Inclusive—Gate valves 2½-in. and larger shall be medium, outside screw and yoke pattern, tested to 500 lb. hydrostatic pressure, with gray-iron bodies, bonnets, discs and yokes; bronze seats and disc rings; and bronze stems.

Gate valves 10-in. and larger shall be bypassed.

Globe and angle valves 2½-in. and larger shall be extra-heavy pattern, tested to 800 lb. hydrostatic pressure, but otherwise to the same general specification.

All valves 2-in. and smaller shall be extra-heavy bronze, tested to 500 lb. hydrostatic pressure.

Boiler Feed Between 125 and 250 Lb. per Square Inch Inclusive—Gate valves 2½-in. and larger shall be extra-heavy, outside screw and yoke pattern, with semi-steel bodies, bonnets, discs and yokes; bronze seats and disc rings; and bronze stems.

Globe angle valves 2½-in. and larger shall conform to the same general specification.

Check valves 2½-in. and larger shall be extra-heavy pattern, with bronze seats and disc rings.

All valves 2-in. and smaller shall be extra-heavy bronze.

Valves shall be tested to 800 lb. hydrostatic pressure.

Exhaust—Gate valves 14-in. and larger shall be outside screw and yoke, low-pressure pattern, suitable for 25 lb. working steam pressure, with gray-iron bodies, bonnets, discs and yokes; bronze seats and disc rings; and rolled steel stems. Where space does not permit using outside screw and yoke, inside screw patterns may be used.

Gate valves 2½- to 12-in. inclusive shall be standard pattern, outside screw and yoke, suitable for 125 lb. working pressure, with gray-iron bodies, bonnets, discs and yokes; bronze seats and disc rings; and rolled-steel stems.

Gate valves 2-in. and smaller shall be standard brass.

Suction and Low-Pressure Water—Gate valves shall conform to the same specification as for "Exhaust" except that in every case bronze stems shall be used.

Check valves shall be standard pattern swing checks with bronze seats and disc rings.

Drains Between 125 and 250 Lb. per Square Inch—Valves shall conform to the specification for those for "Saturated Steam between 150 and 250 lb. per sq.in. inclusive," except for superheated steam when valves next to the pipes drained shall conform to the specification for those for "Superheated Steam."

Low Pressure Drains—Valves shall conform to the specification for those for "Exhaust."

Non-Return and Blowoff Valves

Non-return valves, either globe or angle type, shall be provided in each boiler connection. They shall work quietly and shall automatically prevent the flow of steam from the lines to the boilers and shall be provided with means for closing by hand.

For superheated steam they shall be extra-heavy, cast steel, completely monel mounted, with monel-metal pistons and dashpots if same are internal, and monel-metal stems.

For saturated steam up to 250 lb. per sq.in. they shall be semi-steel, completely bronze mounted, with bronze pistons and dashpots and bronze stems.

Non-return valves shall be installed preferably with stems in a vertical position.

Each blowoff connection shall be provided with one cock and one blowoff valve.

Fittings

Superheated Steam—Fittings 2-in. and larger shall be extra-heavy, cast steel. Fittings 1½-in. and smaller shall be forged or cast steel.

Saturated Steam, Boiler Feed and Drains Between 125 and 250 Lb. per Square Inch Inclusive—Fittings 2½-in. and larger shall be extra-heavy, semi-steel. Elbows for boiler feed shall be long radius where possible. Fittings 2 in. and smaller shall be extra-heavy, gray iron.

Exhaust, Suction, Low-Pressure Water and Low-Pressure Drains—Fittings 14-in. and larger shall be low-pressure, gray iron, suitable for 25 lb. working steam pressure. Fittings 12-in. and smaller shall be standard cast iron.

Flanged elbows for water shall be long radius where possible.

Blowoff—Fittings shall be extra-heavy semi-steel. Long-radius fittings shall be used where possible.

Pipe Flanges and Unions

Van Stone flanges shall fit the pipe closely. The lap shall be turned over and finished off to the inside edge of the bolt holes and faced with a fine tool finish.

Screw flanges shall be made up by machine where possible and on all extra-heavy flanges made up in the shop the pipe shall extend completely through the flange and shall be refaced after making up.

Superheated Steam—Flanges 4-in. and larger shall be extra-heavy high hub steel, Van Stoned. Flanges 3½-in. and smaller shall be extra-heavy steel, screwed.

Saturated Steam Between 150 and 250 Lb. per Square Inch Inclusive—Flanges 4-in. and larger shall be extra-heavy low hub steel, Van Stoned.

Flanges 3½-in. and smaller shall be extra-heavy semi-steel, screwed.

Saturated Steam Between 125 and 149 Lb. per Square Inch Inclusive—Flanges 7-in. and larger shall be extra-heavy high hub semi-steel, Van Stone.

Flanges 6-in. and smaller shall be extra-heavy semi-steel, screwed.

Boiler-Feed Piping Between 125 and 250 Lb. per Square Inch Inclusive—Flanges shall be extra-heavy steel, screwed.

Drain Piping Between 125 and 250 Lb. per Square Inch Inclusive—Flanges shall be extra-heavy semi-steel, screwed.

Exhaust, Suction, Low-Pressure Water and Low-Pressure Drains—Flanges 14-in. and larger shall be standard cast-iron pattern, Van Stoned.

Flanges 12-in. and smaller shall be standard cast iron, screwed.

Blowoff—Flanges shall be extra-heavy semi-steel, screwed.

Unions—On all screwed work a sufficient number of unions shall be used to facilitate repairs. One union shall be used near each screwed valve. Unions 1½-in. and larger shall be flanged and below 1½-in. they shall be gasketless, with non-corrosive seats.

Wrought Pipe

Wrought pipe shall be steel. Standard pipe shall be butt-welded for sizes 3-in. and smaller and lap-welded for sizes 3½-in. and larger. Extra-strong pipe shall be butt-welded for sizes 2-in. and smaller and lap-welded for sizes 2½-in. and larger.

Steam Between 150 and 250 Lb. per Square Inch Inclusive—Pipe shall be full weight 7-in. and smaller. Sizes larger than 7-in. shall be of the following thicknesses or weights per foot: 8-in. 28.55 lb.; 9-in., 33.90 lb.; 10-in., 40.48 lb.; 12-in., 49.65 lb.; 14- to 16-in., inclusive, ⅜ in.; 18- to 20-in. inclusive, 7/16-in.; 22- to 24-in. inclusive, ½-inch.

Steam Between 125 Lb. and 149 Lb., per Square Inch Inclusive, Suction and Low-pressure Water—Pipe shall be full weight 7-in. and smaller. Sizes larger than 7-in. shall be of the following thicknesses or weights per ft.: 8-in., 24.69 lb.; 9-in., 33.90 lb.; 10-in., 34.24 lb.; 12-in., 43.77 lb.; 14- to 20-in. inclusive, 7/16 in.; 22- to 24-in., inclusive, ⅜ inch.

Boiler Feed—Pipe for pressures between 150 and 250 lb., per sq. in. inclusive shall be extra-strong and between 125 and 149 lb., per sq. in. inclusive, shall conform to the specifications for "steam" for the same pressures.

Exhaust Piping—Pipe 7-in. and smaller shall be full weight; 8- to 12-in. inclusive, shall be the same as for "Steam between 125 and 149 lb. per sq. in. inclusive"; between 14- and 18-in. inclusive it shall be ¼-in:; and 20-in. and larger it shall be of the lightest card weight.

Blowoff—Pipe shall be extra-strong.

Drains—Pipe shall be extra-strong.

Welding—Where it is advisable economically, branches shall be welded to main piping, in preference to the use of fittings. All welds so made shall receive a hammer test under hydrostatic pressure three times the working pressure. The fillets on branches, if butt-welded, shall be built up to a radius equal to not less than three times the thickness of the pipe wall.

Bends—Bends shall be used for changes of alignment in preference to fittings. They shall be substantially round in section and free from injurious buckles. Radii equal to not less than six diameters of the pipe shall be used where possible.

Where used for exhaust, suction, and low pressure water, cast iron pipe shall correspond in thickness to "Class B" pipe as specified by the American Water Works Association.

All flange bolts 1½-in. in diameter and smaller shall have square heads and U. S. Standard hexagonal, cold-punched, chamfered and trimmed nuts. For bolts larger than 1½-in. studs with two nuts may be used. When pulled up, the bolt thread shall extend completely through the nut.

Gaskets shall fit inside of bolt holes for all lines not under vacuum. Vacuum lines shall have full face gaskets.

Sheet gaskets up to and including 12-in. size shall be 1/16 in. thick; and for 14-in. and larger they shall be 3/32 in. thick.

Superheated Steam—Gaskets shall be superheat sheet or metal.

Saturated Steam, Boiler Feed, Blowoff and Drains—Gaskets shall be Rainbow or equivalent, or corrugated copper.

Exhaust—Gaskets shall be Rainbow or equivalent.

Suction and Low-Pressure Water—Gaskets shall be cloth-inserted rubber or equal.

Supports

A sufficient number of supports, preferably hangers, shall be provided and so placed that their working stresses shall have a factor of safety of not less than six, assuming that each hanger is bearing its proportion of the load with the line full of water.

Sufficient anchorage shall be provided where necessary.

If roller supports are used they shall have screw adjustments.

Care of Induction Motors

By J. W. Truesdell

One of the most important items in connection with the continuity of motor service is the inspection and cleaning. This should be done by a regular attendant. He will see to it that the oil reservoirs are kept filled, that oil rings move freely and note the general condition of the apparatus, and play in the rotor, vibration, and other defects that may be detected while the motor is in operation.

Weekly inspections are desirable, noting the condition of the ventilating fans, windings, wedges, and the measurement of the air gap, thus giving a check on the bearings. Of the burnt-out windings in induction motors 75 per cent are due directly to low bearings or open-phase operation.

The substantial construction of the induction motor and its simple operating principles compared with the direct-current machine is somewhat responsible for the neglect that the average induction motor receives, where a little more attention would result in longer life and more satisfactory service.

I have found it good practice to give new motors one or two coats of good plastic insulating varnish which dries with a smooth finish. This applies to particular classes of work where the operating conditions are most severe, such as chemical and metallic powder manufacturing plants. The original paint generally dries with a rough surface which makes the cleaning more difficult.

In cleaning motors it is not desirable to use gasoline, but when it is necessary to wash the windings a desirable substitute is carbon tetrachloride, and if used in a moderate way by means of a force gun or any other means with a slight air pressure, it produces a very efficient result, and obviates the danger from fire.

Advantages of Aftercooling in Air Compression

By P. A. BAUMEISTER

SINCE the cooling of air after compression removes part of the energy contained in the air many cannot understand why such aftercooling is necessary. The following discussion of aftercoolers explains why and when this cooling of the air is profitable.

THE aftercooler is essentially a heat remover and usually consists of a nest of tubes in a suitable cast-iron or steel shell. Cold water is circulated through the tubes and the air or gas circulates through the shell outside the tubes. In some cases this process is reversed, the air circulating through the tubes and the water outside. The heat of compression is removed from the air by means of the cooling water. To understand this subject, it will be well to consider why an aftercooler is required and what it may accomplish.

Under all atmospheric conditions air contains more or less moisture. The maximum amount of moisture that can be present in a given space depends on the temperature. The term humidity is a common expression and is simply the ratio of the amount of moisture actually present in a given volume of air to the maximum amount that could be present under the same temperature conditions. When the air contains all the moisture it can hold, we call it saturated or speak of it as having 100 per cent humidity. If lesser amounts of moisture are present, we say the humidity is 50 or 75 per cent. That is, there is only 50 or 75 per cent of the possible moisture present.

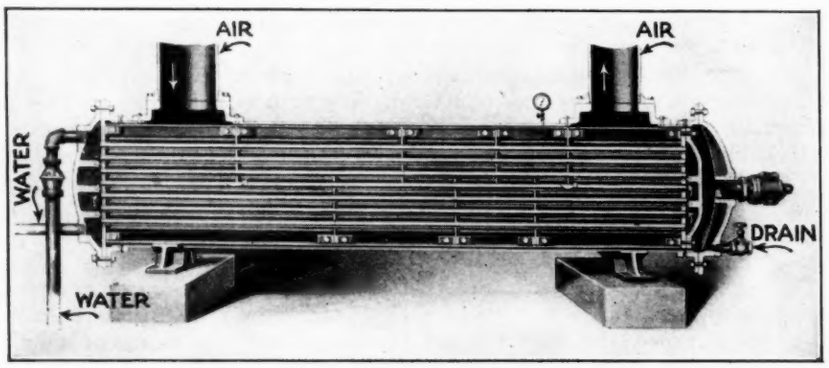
The amount or weight of moisture that can be present in a cubic foot of air increases with the temperature. For example, if we have a cubic foot of air at 75 deg., the maximum weight of moisture that could be present would be 0.001346 lb. which is simply the weight of a cubic foot of steam at 75 deg. F. If this amount of moisture were present, the air would be saturated with moisture. If the air temperature were 120 deg. and the air saturated, the weight of moisture present per cubic foot of mixture would be 0.004924, or 3.65 times as much. This shows the importance of having the compressor intake temperature as low as possible when it is desired to eliminate moisture from the compressed air. When air is compressed, its temperature is raised and per cubic foot of compressed air its moisture-carrying capacity is increased. On the other hand, its volume is greatly diminished, reducing the amount of moisture that can be present, so that these two operations tend to offset each other. Then if we cool the air while compressed, we will reduce the volume and temperature still more, resulting in a precipitation of moisture. For example, if we assume air at 75 deg. F. 60 per cent humidity compressed to 100 lb. and cooled back to 75 deg. F., we would find that in 1,000 cu.ft. of air entering the compressor there would be 0.81 lb. of moisture. This is arrived at as follows:

$$0.001346 \times 1{,}000 \times 0.60 = 0.81 \text{ lb.}$$

Now 1,000 cu.ft. of free air, after being compressed to 100 lb. pressure and cooled to 75 deg. F., occupies a volume of 128.3 cu.ft. The relation of pressures and volumes is found by the equation $P_1V_1 = P_2V_2$, which is the expression for isothermal (constant temperature) compression. This volume of air—that is, 128.3 cu.ft.—would contain, if fully saturated, only 0.173 lb. of moisture, for one cubic foot of space at 75 deg. would contain 0.001346 lb. of water vapor. The difference between 0.81 lb. and 0.173 lb., or 0.637 lb., represents the moisture removed by cooling the air back to the initial temperature.

It is a well-known fact that ordinary pipe lines, particularly if they are long, will radiate considerable heat. The air is cooled in the pipe and moisture will be precipitated. But this moisture condensed by the pipe radiation ultimately reaches the pneumatic tools and has harmful effects. In the first place it washes away the lubricant, causing excessive wear with high maintenance. This is especially true for such types of tools as drills, pneumatic hammers, air hoists, etc., where the wearing surfaces are limited in size. In addition to the necessity for frequent renewals of parts there is a loss in economy due to the greater leakage and air consumption of the tools.

Another serious objection to the presence of moisture in the air is the fact that, owing to the low temperatures caused by the expansions of the air in the tools, this moisture will freeze in the valve ports, etc., making the tool sluggish in its action and greatly retarding production. It is perfectly obvious that because of the high labor charges it is desirable to keep the pneumatic tools working to full capacity as much of the time as possible, even though it may mean the outlay of addi-



MODERN HORIZONTAL AFTERCOOLER

tional capital for equipment. The removal of moisture is then highly desirable in a compressed-air plant.

There are but two means available for reducing the troubles from moisture. One is to take in dry air only and use it at the tools with as little loss of heat as possible. Theoretically this is the best, but practically it is commercially impossible to secure dry air. The other method is to compress the air, cool it and remove the moisture in this way before it is used in the pneumatic tools.

This is easily accomplished by means of an aftercooler which simply reduces the air temperature with a resulting precipitation of a large part of the moisture.

Effect of Cold Water

The writer has found that where very cold water is used, the air leaving the aftercooler sometimes has a humidity less than 100 per cent. That is, there is present in the air less moisture than its temperature would indicate it should carry. This is probably accounted for by the fact that the air immediately surrounding the water tubes is at a temperature below the average. The tubes probably sweat, and before the moisture can re-evaporate it is separated out so that the air actually leaves the aftercooler less than saturated. This shows the advantage of using cold water—the colder the better. A small amount of cold water is better than a larger amount of warm water.

As the chief function of an aftercooler is to remove moisture, it should be drained either by hand or automatically when sufficient condensate has collected.

In cooling the air, its volume is of course decreased. This means that a smaller volume has to be transmitted through the pipe line, representing less pressure-drop loss, or in other words a higher pressure at the tools for the same power input at the compressor.

Of course, in cooling the air there is loss in volume, but this usually occurs anyway in plants using pneumatic tools, because of the long pipe lines, so that the introduction of the aftercooler does not probably mean any additional lost energy and it has the big advantage of getting rid of the moisture.

The use of an aftercooler may actually increase the power required to deliver a foot of compressed air to the tools, but the over-all efficiency of the tools, the men and the plant will be higher.

Other Advantages of Aftercoolers

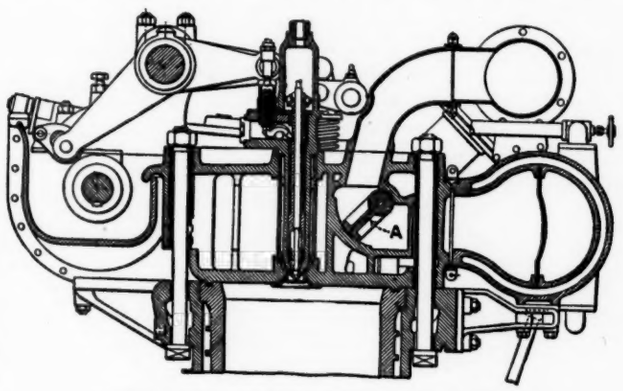
In addition to the foregoing advantages for the use of an aftercooler, there are several others. For example, there will be less expansion and contraction of the pipe lines due to the low and uniform air temperature. Continued expansion and contraction of piping tends to create leaks at joints, gaskets, etc., with loss in economy. There is almost always some oil discharged from the compressor, and this is precipitated and removed in the aftercooler, reducing the possibility of rotting rubber gaskets and also reducing the risk of receiver explosions.

Summed up, these advantages would appear as follows: (1) Reduction of wear and maintenance on pneumatic tools because of moisture removal; (2) greater productions from tools, men and plant; (3) less pressure drop in lines or more production for the same power expenditure; (4) smaller pipe lines; (5) reductions of expansion strains in pipe line with consequent reduction in leaks; (6) removal of oil and tar from air; (7) lessened risk of receiver explosions.

Improvement in Diesel-Engine Construction

One of the difficulties the Diesel-engine designer is striving to overcome is the tendency toward fracture of the cylinder head. The usual Diesel-engine cylinder head is provided with four openings for the fuel valve, starting valve, air admission and the exhaust valve. The temperature around the exhaust-valve opening is much higher than at the admission valve, since the hot gases passing out of the exhaust throw off to the iron walls a part of their heat. The admission-valve cage is cooled by the passage of the fresh air charge, and as a consequence the cylinder head is subjected to unequal heat stresses.

To remove this objectionable condition the Beardmore-Tosi Diesel is provided with a director or deflecting valve, as shown in the illustration. The air charge and exhaust gases pass through the same cylinder-head



DIRECTOR VALVE FOR DIESEL ENGINE

valve, there being two of these valves. The director valve *A* is placed in the passage to the head valves, which passage divides into two branches on the far side of the director, one leading to the air manifold and the other to the exhaust pipe.

The director valve is timed from the camshaft. During the suction stroke of the engine this valve is in a position where the exhaust line is closed and the air line opens. During the firing stroke the director valve covers the passage to the main valve and on the exhaust stroke is moved over to close the air line, giving a free passage to the burnt gases to the exhaust pipe.

The arrangement serves to maintain the entire cylinder head at a fairly low temperature. The two main valves, being placed on each side of the center of the head, not only allow the entire head to be cooled by the fresh air, but also give a large valve opening. For large engines where the cylinder-head temperature conditions are serious, this design appears to promise great merit.

The total sales of large tungsten filament lamps in the United States during 1921 amounted to 160 million, as compared with 202 million during 1920. There were six million carbon lamps sold in 1921, as compared with nine million in 1920, and as reported last year in the N.E.L.A. Lamp Committee Report, there was a reduction in this type of lamp of four million over 1919, so that the early disappearance of the carbon lamp may be looked for. In numbers, tungsten filament lamps in 1921 were 96.4 per cent of the total, compared with 95.7 per cent the year before.

Modern Filtering Methods For Lubricating Systems

By W. F. OSBORNE
Supervisor, Manufacturers' Service, Texas Company

EVERY circulatory system accumulates foreign material from many sources. One of the advantages of such a system is that it washes the bearings clean of any particles of dust that may settle in them from the atmosphere.

Moisture from the air, condensed steam leaking past stuffing boxes, water from leaking coolers, bearing jackets, cylinder jackets, and splashing from manufacturing processes into the system, will accumulate in the oil unless provision is made for their removal. A gradual accumulation of foreign matter in an oiling system will result in abrasion of the bearings, stoppage of oil lines, plugging of oil grooves in bearings and insulation of coolers through deposits of sludges, and will eventually shut down the machine completely. Consequently, some arrangement should always be provided to take care of this foreign material and remove it from the oil.

There are five general methods of cleaning an oiling system: (1) All the oil is removed from the system, all pipes washed out and refilled with fresh oil; (2) all the oil is removed and after being cleaned is returned to the system; (3) a part of the oil is removed at regular intervals, thoroughly cleaned and replaced in the system, this being the batch method; (4) the continuous filtering system, in which all the oil is continuously passed through filters or separators and all foreign material removed before the oil is delivered to the bearings; (5) the partial filtration system, in which a portion of the oil is continuously bypassed through the filters and is automatically returned to the system after being cleaned.

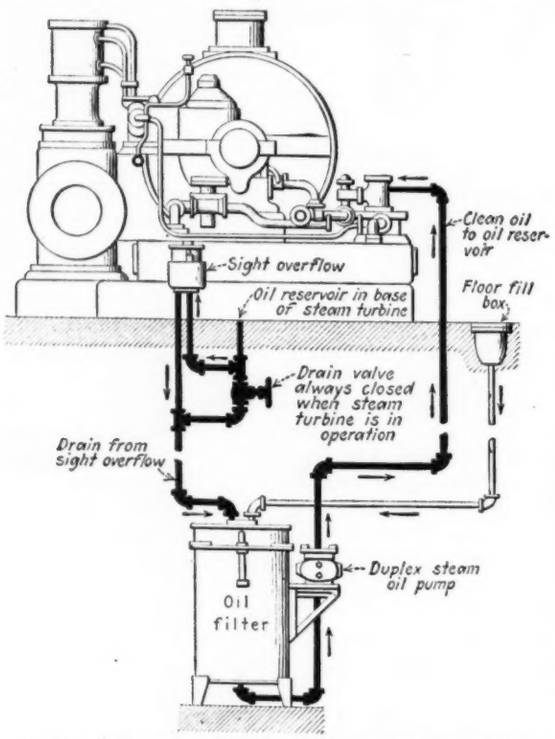

Clean oil to oil reservoir
Sight overflow
Oil reservoir in base of steam turbine
Floor fill box
Drain valve always closed when steam turbine is in operation
Drain from sight overflow
Duplex steam oil pump
Oil filter

FIG. 1. BYPASS METHOD WITH CENTRIFUGAL SEPARATOR

The first method has the advantage that any sludges or deposits that may have accumulated on the pipes or in other parts of the system are removed, thereby preventing any chance of their being loosened at some future time to cause trouble. Such a plan entails a considerable amount of labor in drawing out the oil, washing out the system and refilling with new oil. The old oil, after standing for a time to allow the water and dirt to settle out, is used on some other machinery in the plant. With such a plan the bearings receive good oil only for a short time immediately after the fresh oil has been put in; it gradually becomes contaminated, and lubrication deteriorates until the next period of cleaning. It requires shutting down the equipment while the system is being cleaned, a serious disadvantage where machines must be kept in continuous operation.

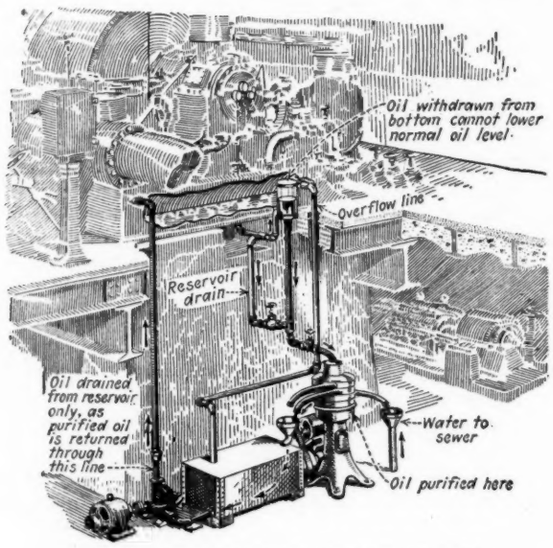

Oil withdrawn from bottom cannot lower normal oil level
Overflow line
Reservoir drain
Oil drained from reservoir only, as purified oil is returned through this line
Water to sewer
Oil purified here

FIG. 2. FILTER WITH BYPASS SYSTEM

In the second method, instead of using the old oil on some other equipment, it is cleaned in suitable filters or separators and returned to the system. This plan has no advantages over the first excepting that it reduces the cost for new oil. It should be remembered that although all foreign material may have been taken out of the oil, it has increased in viscosity and acidity, and unless it is freshened up by the addition of a quantity of new oil, it will gradually become worse as time goes on and may possibly cause trouble through emulsions unless it is carefully watched. Such a method necessitates more frequent cleaning of the system than when fresh oil is put into the system each time.

Under the third plan a portion of the oil is withdrawn from the system at frequent intervals. The equipment being lubricated with the oil remaining in

the system for a short time. This plan has the advantage that the equipment need not be shut down during the oil-cleaning process. The oil that is withdrawn is put through filters or separators and, after it has been cleaned, is returned to the system and mixed with the dirty oil already in the system. With such a method, if the oil is cleaned often enough, it will never get very dirty nor will it ever be entirely clean. The bearings are always lubricated with a slightly dirty oil, but as they are never lubricated with a very dirty oil, such as might occur with the first two methods, results will generally be better.

With the fourth method all the oil is continuously passed through filters or separators, and if they are of the proper size and efficiently constructed, all the oil going to the bearings should be clean and free from any contaminating abrasives or moisture. If the filters regularly and continuously remove all foreign material as fast as it is picked up by the oil, there will be a minimum of deposits in the system and a minimum tendency to form emulsions. The oil will last a long time and will retain its original properties for many months, and sometimes for years even under severe service conditions.

The fifth method, the continuous bypass system, allows a portion of the oil to pass continuously through the filters, where it is cleaned and delivered to the bearings. Such a method is usually employed where

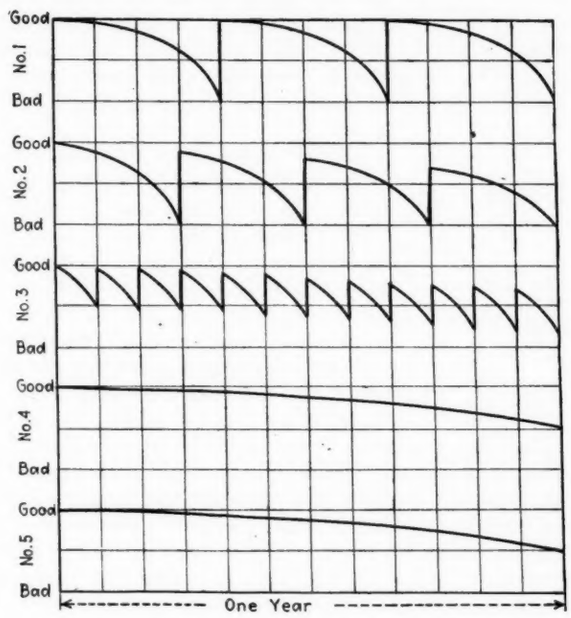


FIG. 3. COMPARATIVE VALUE OF SYSTEMS

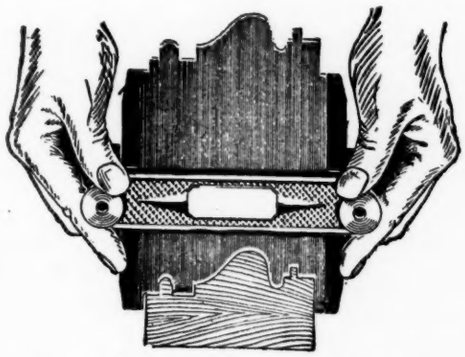
the amount of foreign material entering the oil is very small, and it permits the use of smaller and less expensive equipment than would be required were all the oil to pass continuously through the filters or separators.

In any of these systems the oil coming from the filters or separators should be absolutely free from moisture and solid material of any kind. It makes no difference what the basis of the cleaning system is—gravity, filter cloths or centrifugal force—the equipment cannot be considered efficient unless the oil comes out bright and clear. There are many filtering and cleaning systems on the market, some of which are very efficient if installed in the proper manner and of the proper size. There is a great tendency to purchase an equipment too small to handle the quantity of oil in the system properly, with the result that it works inefficiently and the whole system becomes a constant source of trouble to the engineer.

The charts are intended to give an idea of the comparative value of these five systems with respect to the quality of the oil delivered to the bearings throughout a period of one year. It will be seen that the last two methods are quite superior to the first three in many respects.

Making a Templet in a Few Seconds

An ingenious little tool that seems to have interesting time-saving possibilities was described in a recent issue of *The Power User*, which is published in London. The purpose of the device is to do away with the tedious



IT DOESN'T TAKE LONG TO "MAKE" A TEMPLET THIS WAY

work of filing up templets to fit irregular surfaces. Those who have had to do much repair work around a power plant will remember many cases where it was necessary to make a special templet, as, for instance, when a new piece must be fitted to a broken part. There are many cases also where it would be desirable to have a templet, but where one gets along without it on account of the length of time required to make one. It would be a great boon to be able to obtain an accurate templet in a few seconds, and a tool designed to do that has been brought out by an English company.

As shown in the illustration, the tool consists of a large number of steel or brass strips, each 0.007 in. thick, made accurately to the same length. They are held together loosely, so that they may slide freely, and when set they may be clamped by the thumbscrews shown.

To use the device, it is loosened and set with the ends of the leaves on the surface to be fitted, and is then tapped gently until all the leaves have dropped down with their ends in contact with the surface. The screws are then tightened and the templet is made.

The curve, of course, consists of steps 0.007 in. wide, but it would apparently be smooth enough to allow of fairly accurate work. It will be noticed that the other ends of the leaves form a reverse templet.

Although semi-solid oil will not flow readily and may remain on the sides of the pipe in the refrigerating plant, yet ease in cleaning is obtained and the oil may be made to flow when desired by passing some of the hot gas from the compressor directly into the expansion coils.

Effects of Heating and Cooling in Steam Turbines

An article on the "Developments in Power-Station Design" in the *Engineer*, of London, Eng., says that in 1912 the usual steam conditions specified for new plants were about 200 lb. gage pressure and a total temperature of 588 deg. F., or an initial superheat of 200 deg. F.; but that in 1915 the consulting engineers of the Newcastle-upon-Tyne Electricity Supply Co. decided to adopt a pressure of 250 lb. per sq.in. at the stop valve and a total temperature of 650 deg. F., and specified that the turbines should be capable of withstanding continuously a temperature of 700 deg. F. It was also decided to design the plant for the highest speed permitted by the supply frequency, namely, 40 cycles, and to make the units develop 10,000 kw. with a 75 per cent power factor.

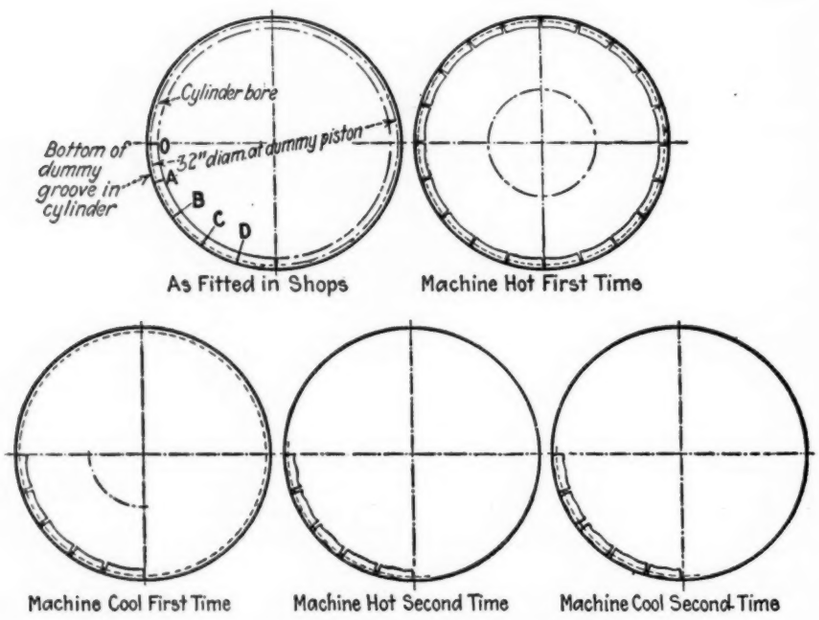


DIAGRAM SHOWING THE EFFECTS OF HEATING AND COOLING IN STEAM TURBINES

The decision to build units on these lines has apparently been fully justified, for tests have shown results that the makers consider to be unrivaled. The difficulties that had to be overcome in order to operate the turbines at initial steam temperatures of 650 to 700 deg. F. were found to be due almost entirely to unequal heating and cooling when starting up and shutting down, and these difficulties were aggravated by the unequal coefficient of expansion of the materials used. On starting up a Parsons turbine from the cold condition, the shroud strip on the blading heats up more quickly than anything else and by its expansion spreads the blades fanwise, the greatest bending stresses being produced at the roots of the outermost blades of a segment or unit. On shutting down the machine, the shrouding strip cools down first, and owing to its contraction the blades are bent in the reverse direction. The greater the circumferential length of the blade segments, the more serious is the effect produced, and if this dilation is sufficiently great, ultimate fracture of the blades at the root is the inevitable result.

In the first of the five 10,000-kw. sets installed in the Carville station, "end-tightened" blade segments composed of manganese copper about 6 in. long were used in the high-pressure cast-steel cylinder. The difference in the coefficient of expansion between the dummy packing or the blading material and that of the cylinder shaft led to trouble, and the sequence of events is shown in the illustration. The top left-hand diagram shows a ring of brass-strip dummy packing originally calked in at the ordinary temperature of the surroundings in 6-in. segments. On starting up the turbine, the brass expanded more than the casing, with the result that the strip was forced out of the groove at the butt joints *A*, *B*, *C*, etc., the weakest points, the effect being shown in the top right-hand diagram. On shutting down the turbine, the brass strip cooled more rapidly than the casing, and owing to the larger coefficient of expansion, contracted to a greater extent, and definite gaps were left between the segments, as shown in the lower left-hand diagram. The next time the turbine was started, however, the brass strip again heated up first and expanded more than the casing, and appeared to become so firmly wedged in the grooves that free expansion was restricted, with the result that hogging took place in the middle of the segments, as shown in the bottom center diagram; while on cooling down, the brass strip contracted freely and the gaps were widened still more, as shown in the last diagram.

The ultimate effect of these results was the formation of large gaps between the segments and creeping of the segments in their grooves, so that in some cases they were butted close together, with a corresponding large gap elsewhere and general displacement out of the grooves. The cylinder blading behaved in a similar manner, while in the case of the rotating blade rings on the shaft, the butted ends of the segments were forced outward, and the blades at the ends became loose. All these troubles, were, however, largely overcome by the simple expedient of inserting both blade units and dummy packing strips in short lengths. In the case of the blading the segments were made about 1½ times the length of the blades, and they were also brazed up solid at the roots, which were accurately faced at the ends, so that creeping was made impossible. The shrouding strip was kept the same length as the blade units, but small gaps were left between adjacent pieces. Dummy piston packing strips were inserted in lengths of about one inch and proved to be entirely satisfactory. During the construction of the later machines for the Carville station further improvements were made.

Steel blade material was adopted, and the individual "lock-root" type of blading was introduced into the shafts, each blade unit consisting of a blade and spacing section riveted and brazed together, the root being heavily serrated on both sides. The blade units were then assembled in grooves with parallel sides and with correspondingly heavy serrations, the last blades of each row being inserted through a lantern space, which

was finally closed by a serrated steel locking piece calked in position with copper calking pieces. After being assembled into a complete blade ring in the shaft, the shroud strip was brazed on to the blade tenons in short lengths, the adjacent ends slightly overlapping so that in service flexibility is permitted without increasing the steam-leakage area. In the latest Parsons turbines the blade units are produced in one piece, a blade root and a spacing section being combined by a special process, which does not involve expensive milling out of the solid or casting the blades into the roots. The experience obtained at Carville has enabled perfect "end-tightened" reaction blading to be produced, and it is claimed to be quite suitable for the high steam temperatures that are now coming into use.

Methods of Testing Connecting-Rod Alignment

By Thomas W. Airey

After fitting up the connecting rod and previous to the rod being placed on the engine, it is usual to subject it to a series of tests.

In Fig. 1 is shown in elevation and plan an ordinary connecting rod, and the requirements are that the line *AA* representing the center of the bore of the small end brasses shall be parallel with the line *BB* which represents the center of the bore of the large end brasses. The distance from the center of the bore of the small end brasses to the center of the bore of the large end brasses, as represented by *C* must be correct in length.

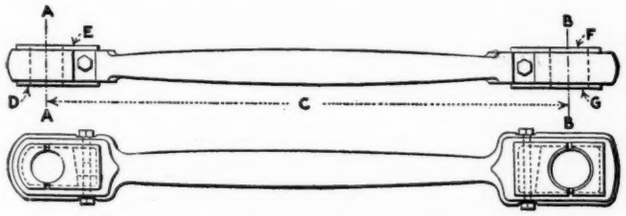


FIG. 1. CONNECTING ROD TO BE ALIGNED

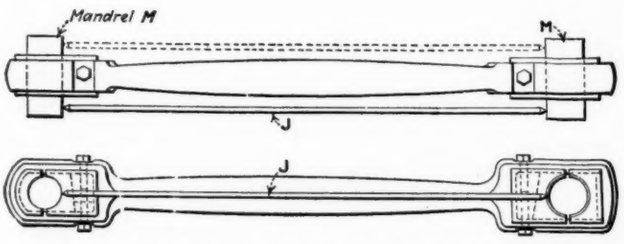


FIG. 2. CHECKING PARALLELISM OF THE BORES

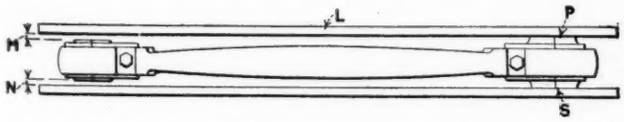


FIG. 3. FINDING THE ROD CENTER LINE ALIGNMENT

The side faces of the large end brasses *F* and *G* must be equidistant or at the required distance from the side faces of the small end brasses *D* and *E*, and the bore of the large and small end brasses *AA* and *BB* must stand parallel to each other.

A common method of testing the parallelism of the centers of the bore of the connecting-rod brasses as represented by *A* and *B*, Fig. 1, is to use parallel mandrels *M* of equal length, one mandrel being fitted to the bore of the small brasses and one to the bore of the large end brasses, as shown in Fig. 2, the mandrel being set to project an equal distance through the brasses on both sides of the rod. The adjusting cotters

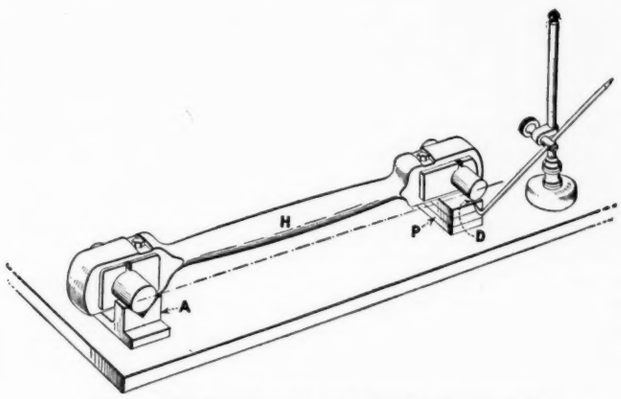


FIG. 4. TESTING ROD ON SURFACE PLATE

are then forced home so that the brasses grip the mandrel firmly.

A gage *J* is made preferably of square-section iron bar of about ⅜-in. diameter, pointed at each end and of a length equal to the correct centers of the rod minus half the diameters of the small end and large end mandrels. The rod is then tested on the one side with the gage J, as shown in the figure by full lines, and then on the other side as shown by dotted lines, the gage J answering a twofold purpose; that is, testing the bores of the brasses for parallelism and for correct centers.

To test the side faces of the brasses, a straight-edge is used as shown in Fig. 3. The straight-edge *L* is held firmly against the side faces of the large end brasses as at *P* and the distance *M* measured. The straight-edge is then used in the same manner on the other side, *S*, and the distance *N* is measured. If the *M* and *N* measurements are the same, the rod is said to be true in this direction.

The testing of the small end brasses is made in a similar manner by holding the straight-edge against the side faces of the small end brasses in the same way as described for the large end.

To test the mandrels for parallelism in the horizontal plane the method outlined in Fig. 4 is employed. Using the mandrels, the large end of the rod is supported on two V-blocks *A* on a true plate or marking-off table as shown in the drawing, the small end resting on packing pieces *P*. The mandrel in the small end brasses is then tested for parallelism. A scribing block or surface gage is placed on the marking-off table and the arm is set just to touch the under side of the mandrel at *D*, and if the other end of the mandrel when tested by the scribing block coincides with the setting, then the bores of the large and the small end brasses are parallel in the direction of the line *H*, Fig. 4. In erection work a marking-off table is seldom at hand. Equally serviceable is the platen of a planer such as found in most machine shops. The platen is true enough for this work.

Comparative Tests on Coal and Oil Burning Boilers

By S. A. Smith, Jr.

Recently, comparative tests were made on two small boilers at the National Pipe Bending Co.'s plant in New Haven, Conn., for the purpose of ascertaining the relative cost of generating steam by oil and by coal. The boiler installation at the plant consists of two Bigelow horizontal return-tubular boilers of identical design, each having 1,268 sq.ft. of water-heating surface, the one equipped to burn fuel oil, the other coal (hand-fired).

The results are interesting because they show that in a small plant producing about 4,000 lb. of steam per hour for a period of ten hours daily, oil can be burned as economically as coal. If the load fluctuates considerably, there may be a substantial saving by the use of fuel oil. In the case in question only one boiler is in use at a time. The cost of labor, therefore, does not enter into the comparison, because in this particular plant it is possible to combine the functions of the engineer and fireman in one man, whether coal be burned

TABLE I. REPORT OF TEST ON BOILER USING FUEL OIL

Number and kind of boilers	One horizontal return-tubular
Water-heating surface, sq.ft.	1,268
Duration of test, hours	7
Steam pressure by gage, lb. per sq.in.	77
Temperature of feed water entering boiler, deg. F.	206
Temperature of escaping gases leaving boiler, deg. F.	492
Force of draft between damper and boiler, in. of water	0.13
Oil fired per hour, lb.	304
Weight of water fed to boiler per hour, lb.	4,000
Equivalent evaporation per hour from and at 212 deg., lb.	4,150
Equivalent evaporation per hour per square foot water heating surface, lb.	3.27
Water fed per pound of oil, lb.	13.1
Equivalent evaporation per pound of oil, lb.	13.6
Calorific value of one pound of oil, B.t.u.	18,520
Efficiency of boiler and furnace, per cent	71.5
Flue-gas analyses (average), per cent by volume:	
(*a*) Carbon dioxide (CO_2)	9.9
(*b*) Oxygen (O_2)	6.5
(*c*) Carbon monoxide (CO)	0.0
Cost of Steam Generated by Oil	
Total steam used for auxiliary purposes incident to operation on oil, lb. per hr.	285
Weight of water fed to boiler, lb. per hr.	4,000
Steam available for other uses, lb. per hr.	3,715
Oil used, lb. per hr.	304
Cost of oil per lb., cents	0.636
Fuel cost of steam available for plant use, including feed-water pump, cents per 1,000 lb.	52.1

or oil. If the plant were twice as large, so that it became necessary to employ an extra man as fireman when coal was being burned, the saving by burning oil would be greater, for when oil was being burned this extra man could be released and the entire plant cared for by one combined fireman and engineer as before.

Fuel oil is delivered to the plant in tank cars equipped with heating coils. Before the oil can be pumped from these cars, it must be heated for about twelve hours by passing live steam through the coils. At the end of this time the oil is sufficiently fluid to be pumped into the yard storage tank. Here again live steam must be used to keep the oil at a moderate temperature to facilitate pumping the daily supply from the storage tank to a service tank within the power plant. The same pump that empties the tank car into the storage tank also fills the service tank from the storage tank.

A second steam pump, located in the power house, supplies the burner with oil from the service tank. The heat in the exhaust from this pump is utilized to give the fuel a final heating on its way to the burner. The service tank is equipped with heating coils, and a certain amount of steam is used each day in these. Moreover, steam is used by the oil burner to atomize the fuel.

Before a fair comparison of the two boilers could be made, it was necessary to determine how much steam was used for pumping, heating and atomizing the oil. The quantity of steam used by the feed pump does not enter into the comparison, as this is constant for a given load irrespective of what fuel is used.

All the various quantities of steam used for auxiliary purposes when burning oil, were either measured or estimated from the best available data, and from them a figure was obtained that represented the number of pounds of steam for all auxiliaries (except the feed pump) chargeable to each hour's operation of the oil-burning boiler. This figure was then subtracted from the hourly evaporation of the oil-burning boiler. From the fuel consumption and the cost of fuel the cost of steam per thousand pounds was calculated to be 52.1 cents for oil, and 55.7 cents for coal. Although these figures are close, the advantage of cleanliness and flexibility which the oil-burning system possesses turns the balance clearly in favor of oil.

The low efficiency of the coal boiler will be noted. This is largely accounted for by imperfect combustion. indicated by the presence of *CO* in the flue gas. Since the load fluctuates between comparatively wide limits, it is necessary to change the draft frequently. Thus it is impossible to maintain for very long the best conditions of combustion. It is therefore not unreasonable to find an efficiency considerably lower than if the boiler were operated at constant load. In the case of the oil-fired boiler closer regulation can be

TABLE II. REPORT OF TEST ON BOILER USING COAL

Number and kind of boilers	one horizontal return-tubular
Water-heating surface, sq.ft.	1,268
Grate surface, sq.ft.	33
Distance from grate to nearest heating surface, ft.	2.59
Duration of test, hr.	9.83
Steam pressure by gage, lb. per sq.in.	78
Temperature of feed water entering boiler, deg. F.	212.0
Temperature of escaping gases leaving boiler, deg. F.	524.0
Force of draft between damper and boiler, in. water	0.21
Weight of coal as fired, per hour, lb.	529
Water evaporated per hour, lb.	3,910
Dry coal per hour, lb.	508
Percentage of ash and refuse based on dry coal	6.2
Equivalent evaporation per hour from and at 212 deg., lb.	4,050
Equivalent evaporation per hour per square foot of water heating surface, lb.	3.2
Water fed per pound of coal as fired, lb.	7.41
Equivalent evaporation per pound of dry coal, lb.	7.96
Calorific value of one pound dry coal, B.t.u.	14,722
Efficiency of boiler, furnace and grate (dry coal), per cent	52.6
Coal analysis, per cent:	
(*a*) Moisture	3.95
(*b*) Volatile matter	17.4
(*c*) Fixed carbon	73.4
(*d*) Ash	5.25
(*e*) Sulphur (separately determined)	0.51
Fluo-gas analysis (average), per cent by volume:	
(*a*) Carbon dioxide (CO_2)	11.4
(*b*) Oxygen (O_2)	6.8
(*c*) Carbon monoxide (CO)	0.44
Cost of Steam Generated by Coal	
Water fed to boiler, lb. per hr.	3,910
Coal used per hour (as fired), lb. per hr.	529
Cost of coal, cents per lb.	.4125
Fuel cost of steam, cents per 1,000 lb.	55.7

effected, and fluctuations in the load can be met with less sacrifice of efficiency than is possible with coal.

These tests, the principal results of which are shown in the tables, were carried on by graduate students of the Sheffield Scientific School under the supervision of Professors Dudley and Lockwood, of the school.

The bursting of a superheater tube, working in connection with a Lancashire boiler in a Glamorgan cement factory, was caused, according to the official report, by its wasting away through erosion and overheating. The gradual wasting of the tubes in superheaters of this kind is to be expected, and it appears necessary to remove a tube occasionally for examination after the apparatus has been in use for any lengthy period of time.—*The Engineer* (London).

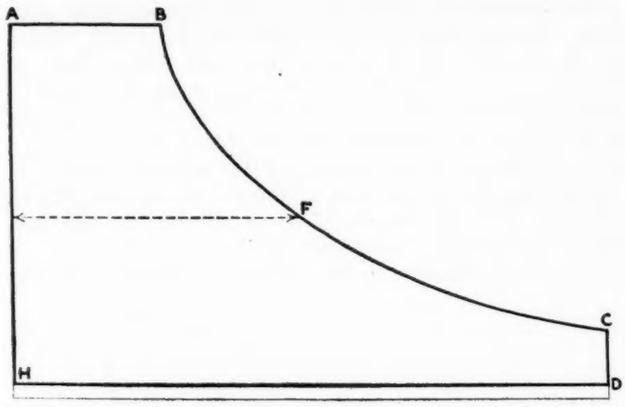


FIG. 1. STEAM FED TO ENGINE WITHOUT CLEARANCE

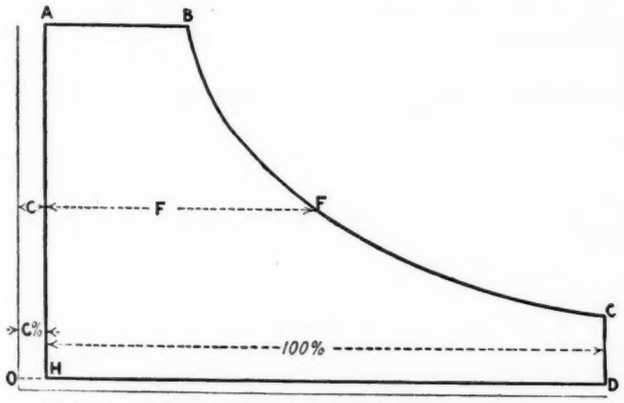


FIG. 2. ADDITIONAL STEAM CONSUMPTION WITH CLEARANCE

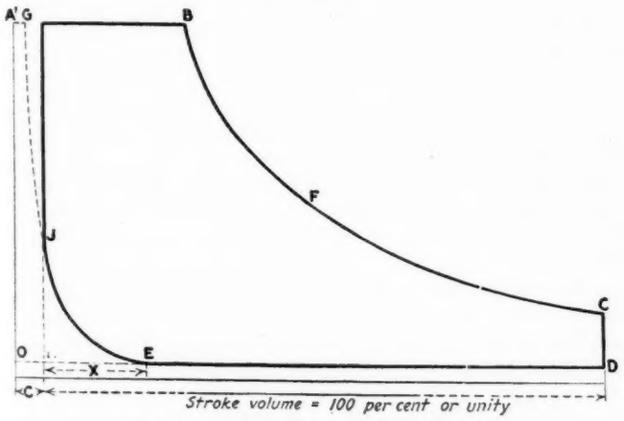


FIG. 3. EFFECT OF COMPRESSION

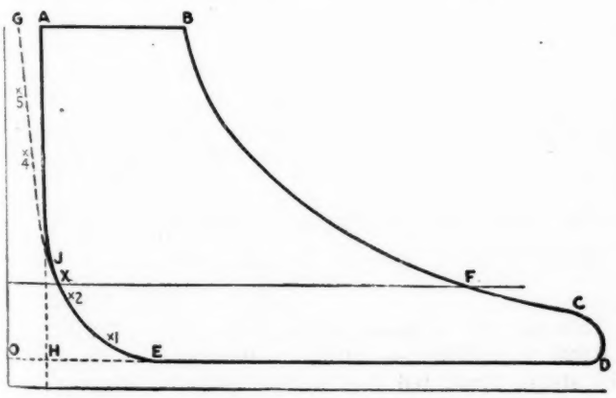


FIG. 4. CORRECTION FOR CLEARANCE STEAM

Steam Consumption Accounted For by Indicator Diagram

IN ANY given engine the diameter, the stroke and the revolutions per minute are known. If steam were a gaseous substance like air, which does not condense upon expanding, the indicator diagram could be used to calculate the exact amount of steam supplied per indicated horsepower-hour. Steam, however, upon first entering the cylinder experiences a cooling effect from the cylinder walls and partly condenses. In expanding part of the energy is converted into work, and even if the steam was dry saturated at the beginning of expansion, part of it would condense since the work done by the steam robs it of part of its latent heat and the heat remaining is insufficient to keep all the supply in the steam state.

For these reasons, while the indicator diagram may be used to calculate the water rate of the engine, the result by no means represents the quantity of steam actually fed to the engine per indicated horsepower. However, the water rate accounted for by the indicator diagram does provide a means of comparing the steam that would be used in the engine if no condensation occurred with the steam actually supplied.

The volume generated by the piston travel, or, as it is sometimes called, the *swept volume*, may be determined by the expansion

$$V = \frac{A}{144} L \times 60N$$

where

V = Generated volume in cubic feet per min.;
A = Piston area in sq. inches;
L = Piston stroke in feet;
N = Number of strokes per minute, or 2 × r.p.m.

This provides a convenient way to find the generated volume per indicated horsepower by use of the formula for the indicated horsepower. This formula says that $i.hp. = \frac{PLAN}{33{,}000}$, where P is the average of the mean effective pressure of the two cylinder ends.

Dividing the volume equation by the indicated horsepower equation, we have

$$\frac{V}{i.hp.} = \frac{\frac{AL60N}{144}}{\frac{PLAN}{33{,}000}} = \frac{A \times L \times 60 \times N}{144} \times \frac{33{,}000}{PLAN}, \text{ or}$$

$$\frac{V}{i.hp.} = \frac{13{,}750}{P}$$

This means that the volume in cubic feet swept through by the piston per indicated horsepower per hour is equal to 13,750 divided by the average of the two mean effective pressures. The water rate for one end may be determined by using the same equation and substituting for the average of the two mean effective pressures, the mean effective pressure of the end in question and by using the brake horsepower of the end in question.

If the engine had no clearance and the exhaust valve did not open until the end of the stroke, giving an indicator diagram similar to Fig. 1, we could find the weight of steam supplied to the cylinde

by looking up in a steam table the density at the pressure at C. Calling the weight in pounds per cubic feet at C, W_c, the weight of steam in the cylinder at C, which is the amount fed to the engine, is VW_c. The steam volume in cubic feet per horsepower hour is $\frac{13{,}750}{P}$; the weight of steam per indicated horsepower is then $SC = \frac{13{,}750}{P} W_c$.

If any other point, such as F is taken, the steam consumption may be obtained by substituting in the foregoing equation the weight per cubic foot of steam at the pressure at F, or W_f in place of W_c and remembering that at F the volume is not the total cylinder volume, but some fraction of it which we will call F, or in case of Fig. 1 assume this to be ½ stroke or 0.5, considering the total stroke as 1, or unity. The steam consumption is then

$$SC = \frac{13{,}750\, W_f}{P}$$

This will give the same result as when the total cylinder volume was taken, for all the steam in the cylinder at C is likewise in the cylinder at F, assuming that no condensation or re-evaporation takes place, and the steam at F weighs more per cubic foot.

In an actual engine some clearance exists and the volume of steam at the end of the stroke is not HD, or unity, but $HD + HO$ when HO is the clearance volume, Fig. 2. We are now dealing then with a total volume of $1 + C$ when C is the clearance volume in per cent. Likewise if the point F be used in the calculations, the volume is not F as with no clearance, but is $F + C$. Replacing F by $F + C$, the pounds of steam per indicated horsepower become

$$SC = \frac{13{,}750}{P} (F + C)\, W_f$$

If the exhaust valve closes early, as at E in Fig. 3, a volume of steam equal to $OH + HE$ is trapped in the

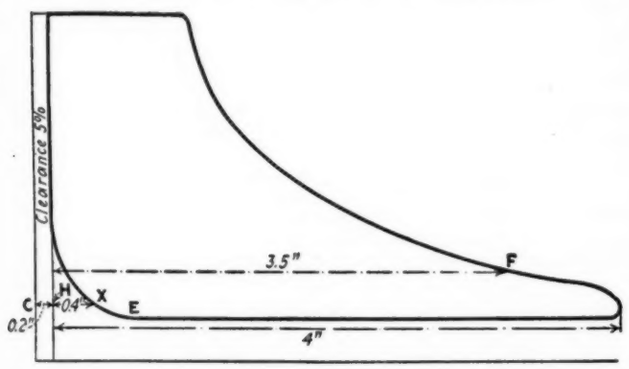


FIG. 5. STEAM CONSUMPTION FROM ACTUAL DIAGRAM

cylinder and is compressed, the volume and pressure following the hyperbolic curve EJ. If a diaphragm is imagined to be stretched across the end of the cylinder separating the trapped steam from the cylinder steam, the flow of boiler steam in through the admission valve compresses this clearance steam, reducing its volume and increasing its pressure along the extension JG of the compression line EJ. It is at once apparent that only that portion of the clearance space represented by GA is filled with live steam. The weight of the clearance steam, whose volume is represented by $A'G$, is the same as at E, since both represent the trapped steam in two different conditions.

The weight of steam fed to the cylinder with compression and clearance is not equal to the swept volume at C, or HD times the weight per cubic foot or $W_c\,(1 + C)$ or to the swept volume at F times its weight per cubic foot at F or $W_f\,(F + C)$. From this weight must be deducted the weight of steam trapped in the cylinder by the closing of the exhaust valve. If the volume HE in per cent of the stroke volume HD be called X, then the weight of steam trapped by the closing of the exhaust valve becomes $W\,(X + C)$.

The steam supplied to the engine per indicated horse-

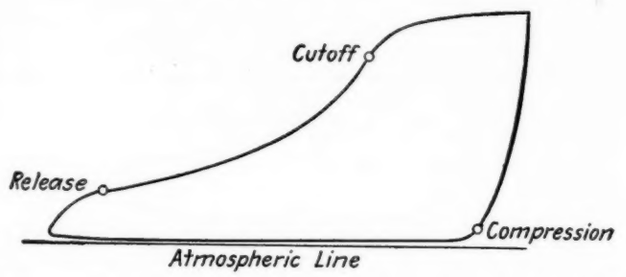


FIG. 6. A.S.M.E. SUGGESTIONS FOR LOCATION OF POINTS

power in an engine with clearance and compression is expressed as

$$SC = \frac{13{,}750}{P} (F + C)\, W_f - (X + C)\, W_x$$

It is not necessary to take the point E where compression starts at X. Any point on the compression line may be taken, provided the weight per cubic foot W_x be taken as that corresponding to the pressure at the point taken. For example, in Fig. 4, any point X_1, X_2, may be used in the formula $W_x\,(X + C)$ where X is the per cent of the stroke volume at X, or X_2. It is possible by constructing the extension of the compression line FG to use any point as X_4 or X_5. In this case the volume filled with the trapped clearance steam is not $X + C$ but, as is apparent from Fig. 4, is $C - X$ and must be so used in the calculations.

Example: The diagram shown in Fig. 5 shows with a 40 scale a m.e.p. of 47.5 lb.; clearance, 5 per cent. How much steam is accounted for per horsepower per hour?

Let us select the points F and X from which to make our measurements. The whole length of the diagram is 4 in., the length to the point F, 3.5 in. The fraction F of the stroke completed at this point is therefore $\frac{3.5}{4} = 0.875$. The distance XH equals 0.4 in., and the fraction of the return stroke uncompleted at the point X is $\frac{0.4}{4} = 0.1$.

The pressure (absolute) at F is 32.7 lb., at X it is 19.4 lb. The weight of steam per cubic foot at 32.7 lb. is 0.0789 at 19.4 lb. 0.0483. Then $C = 0.05$, $F = 0.875$, $X = 0.1$, $W_f = 0.0789$, $W_x = 0.0483$, and m.e.p. = 47.5.

The steam accounted for per horsepower per hour is

$$SC = \frac{13{,}750}{47.5} \times [(0.875 + 0.05)\ 0.0789 - (0.1 + 0.05)\ 0.0483]$$

This may be reduced to the form $SC = 289.47 \times [(0.925 \times 0.0789) - (0.15 \times 0.0483)] = 19.03$ lb. The steam accounted for by the indicator diagram is 19.03 lb. per indicated horsepower.

To make the computation easy, a point F should be chosen so that a horiztonal line FX will cut the compression line before the admission line begins at J. The steam consumption per indicated horsepower becomes

$$SC = \frac{13{,}750}{P} W_f(F + C) - W_x(X + C)$$

and since in this case $W_f = W_x$ and the expression becomes

$$SC = \frac{13{,}750}{P} W_f(F - X)$$

The American Society of Mechanical Engineers, however, recommend in the test code that the point F on the expansion line be taken near the point of cutoff or of release and that the point on the compression line be taken near to the point of exhaust valve closure, as indicated in Fig. 6.

It is possible to make a graphic comparison of the steam accounted for by the indicator diagram and the

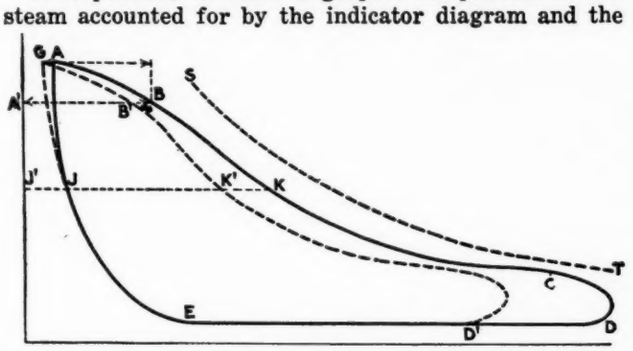


FIG. 7. COMPARISON OF ACTUAL STEAM AND INDICATED STEAM VOLUMES

amount actually supplied to the cylinder. In Fig. 7 the expansion curve of the indicator diagram is corrected by first extending the compression line to G. The steam supplied to the engine is then GB. If this volume be measured from the clearance line, the length $A'B'$ will represent the volume filled with the steam if no trapped steam existed in the clearance. By deducting the trapped steam volume JJ' from the total $J'K$ as shown on the diagram, the volume $J'K'$ represents the volume of the cylinder feed measured from the zero clearance line. Making these corrections all along the expansion and release lines gives the cylinder feed expansion line $B'D'$.

We can find the weight of steam fed to the cylinder per stroke by dividing the total water consumption per hour found by weighing the condensate or the boiler feed by the product of the indicated horsepower calculated from the diagrams and the number of strokes per hour. Assuming the steam to stay dry during expansion, we can find in the steam tables the volume of this weight of dry saturated steam at a number of pressure values. Setting these volumes down on the diagram, measuring from the zero clearance line, we get the saturated curve ST, the distance between the corrected expansion line $B'D'$ and ST at any pressure shows the amount of water in the cylinder.

As already stated, the steam accounted for by the indicator diagram is by no means the total steam supplied per indicated horsepower. Even with the engine in good mechanical condition the water unaccounted for amounts to from 10 to 45 per cent, the percentage varying with the type of engine, the steam and exhaust pressures, etc. Engines will in time show leaks, so that the discrepancy may amount to as high as 60 per cent.

Compound Ammonia Compression*

By G. A. Horne

In view of the comparatively small reduction in horsepower per ton effected by using intermediate liquid cooling, the author is still of the opinion that in small installations, particularly where the ratio of pressures is low, as in ice making, the intermediate liquid cooler should be eliminated. In larger plants with higher compression ratios, it becomes a simple matter of figuring the additional cost of the intermediate liquid cooler, including insulation, in order to determine whether the slight gain in efficiency as computed over a yearly period warrants its installation.

In view of the practice sometimes employed of cooling the low-pressure discharge gas partly or entirely with liquid ammonia, the author has made several observations and comparisons in actual practice, in which gas from the intermediate cooler, cooled by water, was delivered to the high pressure cylinder with practically no additional cooling by ammonia, also where additional cooling with ammonia was used. He was unable to find any reduction in horsepower per ton in the tests made with this secondary cooling by ammonia. It is well to bear in mind that any increase in volumetric efficiency and corresponding decrease in total horsepower produced in the high-pressure cylinder, due to such cooling by ammonia, is at the expense of a reduction in tonnage. Whatever ammonia is used for this purpose is not available for actual refrigerating capacity. He has, therefore, made a careful theoretical calculation based on the exact figures of a test run on Jan. 20, 1922, using a specific heat value of 0.60 for the ammonia at the intermediate pressure, with the results shown in Table I.

TABLE I. RESULTS OF COOLING GAS WITH AMMONIA

	Case I Cooling Gas With Ammonia	Case II Without Cooling Gas With Ammonia
Temperature of gas to h.-p. cylinder, deg. F.	32.3	70.0
Liquid evaporated to cool gas, lb. per min.	1.70	.....
Liquid to brine cooler, lbs. per min.	37.30	39.0
Indicated horsepower, l.-p. cylinder.	75.70	79.0
Indicated horsepower, h.-p. cylinder.	84.25	94.0
Total indicated horsepower	159.95	173.0
Tonnage in brine cooler	100 50	106.0
Indicated horsepower per ton of refrigeration	1.59	1.62

The saving in power indicated is less than 2 per cent with a corresponding reduction in available tonnage of over 5 per cent. The calculation for one horsepower in the high-pressure cylinder in Case II is made a direct proportion of the B.t.u. work as actually obtained in Case I, corresponding to the Mollier diagram, according to conditions of Case II. In view of the actual results and theoretical calculations, it seems evident that cooling gas with ammonia between stages is of practically no value in reducing power, and it does distinctly reduce the capacity of the compressor, which is always established by the ammonia handled in the low-pressure cylinder.

The author fully agrees with the contention that the selection of compound compression or simple compression for any refrigerating system must be made on the basis of a comparison of original cost of plant and the operating cost, as should be the case with the selection of any kind of machinery. He believes that the tests

*Extract of paper read before the Spring Meeting of the American Society of Refrigerating Engineers, Detroit, Mich., May 24, 1922.

described in his paper and the brake horsepower derived therefrom will be of value in determining the cost of power under different pressure ratios for both simple and compound operation. In this paper the author has not gone into the question of first cost, but from his experience in general it can be stated that the original cost of a compound system for the same tonnage output would not be much in excess of a simple system, particularly if the liquid intercooler was eliminated.

Calculations made on the basis of these tests show conclusively that equal work in the cylinders gives lowest horsepower per ton of refrigeration. All the tests of the second series were, therefore, conducted under conditions that closely approximated equal work in the two cylinders, excepting the test of Jan. 24, which was such a low ratio of compression that equal work was not possible even with all clearance pockets open on the low-pressure cylinder. It will be interesting to note the decided reduction in horsepower per ton in the tests of this series compared with the series published in the A. S. R. E. Journal, Vol. 8, No. 4. The author attributes this largely to the fact of correct cylinder ratios, giving approximately equal work in both cylinders.

TABLE II. EFFECT OF LIQUID FORECOOLING AND LIQUID INTERCOOLING

	Case I Without Liquid Fore-Cooling or Intercooling	Case II Liquid Forecooling, No Liquid Intercooling	Case III Liquid Inter-cooling, No Forecooling	Case IV (Actual Test) Liquid Fore-Cooling And Intercooling
1. Total liquid circulated, lb. per min.	39.0	39.0	45.0	42.42
2. Temperature liquid to intermediate receiver	.....	.....	85.0	60.7
3. Temperature liquid to brine cooler	85.0	60.7	21.1	21.1
4. Intermediate pressure corresponding to item 3	.....	.....	49.3	49.3
5. Total heat per lb. saturated vapor at intermediate pressure	.....	.....	618.1	618.1
6. Total heat per lb. liquid entering intermediate receivers	.....	.....	137.7	110.
7. Available latent heat at intermediate pressure	.....	.....	480.4	508.1
8. Latent heat at intermediate pressure B.t.u. per lb. NH_3	.....	.....	552.3	552.3
9. Weight liquid entering intermediate receivers	.....	.....	39.0	39.0
10. Temperature of vapor entering intermediate receivers	74.	74.	74.	74.0
10A. Temperature of vapor entering high-pressure cylinder	32.3	32.3	32.3	32.3
11. Temperature drop of vapor in intermediate receiver	41.7	41.7	41.7	41.7
12. Specific heat of vapor in intermediate receiver, assumed	0.53	0.53	0.53	0.53
13. Heat rejected by vapor in intermediate receiver (B.t.u. per lb. NH_3)	22.1	22.1	22.1	22.1
14. Liquid evaporated in intermediate receiver to cool vapor (Item 13 × Item 9 ÷ Item 8 + item 13)	1.62	1.62	1.62	1.62
15. Weight liquid to brine cooler, lb. per min.	37.38	37.38	37.38	37.38
16. Pressure in brine cooler, lb. per sq.in.	—2.15	—2.15	—2.15	—2.15
17. Boiling point of NH_3 at brine cooler pressure	—30.6	—30.6	—30.6	—30.6
18. Total heat, saturated vapor at brine cooler pressure	600.6	600.6	600.6	600.6
19. Total heat of liquid entering brine cooler	137.7	110.0	65.8	65 8
20. Available latent heat at brine cooler pressure	462.9	490.6	534.8	534.8
21. Temperature of suction vapor at machine	—17.2	—17.2	—17.2	—17.2
22. Sensible heat absorbed per lb. vapor (item 17—item 21 × 0.51)	7.37	7.37	7.37	7.37
23. Total heat absorbed in brine cooler (B.t.u. per lb.)	470.27	497.97	542.17	542.17
24. Total heat absorbed in brine cooler B.t.u. per min.	17,650	18,640	20,300	20,300
25. Tonnage by NH_3 circulated	88.25	93.2	101.5	101 5
26. Indicated horsepower low-pressure compressor	75.7	75.7	75.7	75.7
27. Indicated horsepower high-pressure compressor (item 1 ÷ 42.42 × 84.25)	77.4	77.4	89.4	84.25
28. Total indicated horsepower	153.1	153.1	165.1	159.95
29. Indicated horsepower per ton of refrigeration	1.735	1.643	1.625	1.575
30. Gain in horsepower per ton, case 2 over case 1, 5.3 per cent				
31. Gain in horsepower per ton, case 3 over case 1, 6.2 per cent				
32. Gain in horsepower per ton, case 4 over case 2, 4.1 per cent				
33. Gain in horsepower per ton, case 4 over case 1, 9.3 per cent				

Low-pressure suction,—2.15 in. of mercury; high-pressure discharge, 165 lb. per sq.in. gage; liquid to brine cooler, 37.38 lb. per min.; low-pressure discharge cooled to 74 deg. F., with water, temperature of liquid from receiver, 85 deg. F.; ratio, absolute pressures, 13 to 1; practically equal work in low-pressure and high-pressure compressors.

After completing seven tests, it was found possible to deduce an empirical formula for determining the correct ratio of cylinder-displacement volumes for two-stage compressors. Without intermediate liquid cooling this is

$$V = 0.9\sqrt{R}$$

where

V = Ratio of low- to high-pressure displacement volumes.

R = Ratio of absolute low suction to high discharge pressures. With intermediate liquid cooling,

$$V = [0.9\sqrt{R} - (.005t - t_1)]$$

where

t = Temperature liquid to intermediate receiver.

t_1 = Temperature liquid from intermediate receiver.

For example, $R = 9$, $t = 70$ deg. F., $t_1 = 10$ deg. F. Solving, $V = 2.55$, or the correct ratio of low- to high-pressure displacement volumes.

The author takes this occasion to emphasize the importance of correct ratio of displacement volumes, particularly as he believes there has been a rather wide difference of opinion on this point. In applying this formula to a common summer ice-making condition, say of 20 lb. per sq.in. gage suction and 185 lb. per sq.in. gage discharge pressure, or a ratio of absolute pressures of six to one, with 30 deg. cooling of the liquid, $V = 2.3$. The point might be made that a given cylinder ratio is correct only for one set of conditions, but the answer to that is found in having a suitable arrangement of clearance pockets on the cylinders. This arrangement of clearance pockets should be such that the highest pressure ratio expected would be satisfied when all pockets are closed on the low-pressure cylinder during the season of heaviest load, which is usually when the condenser pressure is highest. It has been found that the pockets can readily be used to regulate cylinder ratios and at the same time allow reduction in capacity at the time such reduction is desired. I would suggest, for example, that if the maximum ratio of pressures expected required a cylinder ratio of 2.6 to 1, an arrangement of pockets should be provided to allow a reduction in cylinder ratios of about 1.8 to 1.

The action of a spray pond depends on the cooling of water by evaporating part of it and thus taking from what is left the heat of vaporization necessary to do the evaporating. Conduction and convection are not relied upon for cooling. This effect is present, however, to a small extent in any cooling system, as some of the water evaporates and carries away heat in the form of steam. Many people do not realize that the maximum cooling obtainable in a spray pond is dependent on the relative humidity. This factor is more important than the air temperature, because it is possible to cool water below the air temperature on days of low humidity.

EDITORIALS

Twenty Million Horsepower in the Making

APPLICATIONS for permits and licenses from the Federal Power Commission now represent a total of more than twenty million horsepower projected capacity. Over three hundred such applications have been made, about one-quarter of them having been acted on by permit or license, representing three and one-third million horsepower for the installations approved. The work on these approved projects is in many cases well under way, and the Commission is acting as rapidly as possible on the other cases, most of which will no doubt receive official approval and represent real construction in the coming months.

The showing thus made is ample demonstration that the country needed Federal power legislation. Moreover, it is a demonstration that the present commission scheme is going to be a success in stimulating power development. If all of the twenty million horsepower proposed by these three hundred projects becomes available, it will add power facilities that are about double the present hydro-elecric development of the country. Much of the need for power in all sections of the country would thus be met by sound engineering development governed by reasonable Federal supervision.

But further than this one must not overlook what this means to the industry, to the makers of equipment entering into a hydraulic plant and system, to the labor involved and, finally, the engineering service required. At an average cost of, say, two hundred dollars per horsepower, this would represent an ultimate expenditure of four billion dollars or an immediate expenditure of seven hundred million.

Whether it be small irrigation projects or some tremendous development such as that on the Boulder Canyon of the Colorado River, or the Utah Power and Light development proposed for the Green River, it makes no difference. The encouragement of Federal supervision is being afforded impartially, and the country is certain to gain greatly by the insistence upon sound engineering and reasonable financial conditions of development.

Figures Justify Coal Regulation

ABOUT two years ago the coal operators secured a court order restraining the Federal Trade Commission from further efforts in demanding information from the coal industry. That such action was advisedly taken, from the operators' viewpoint, is apparent from the recent report of the Commission to Congress on "Investments and Profit in Soft Coal Mining."

Although incomplete, because of the restrictions, the report covers over eleven hundred companies and may be taken, at least, as indicative of the industry. Based on the actual investment in coal-mining properties, including bonded indebtedness and large undeveloped resources, the average annual rates of net income (after deducting production and selling costs) were, in 1916, eight per cent; in 1917, twenty-nine per cent; in 1918, eighteen per cent; in 1919, six per cent; and twenty-three per cent for the first nine months of 1920. These figures do not include profits of selling companies although, according to the Commission, many of these are affiliated with or owned by the same interests that mine the coal.

Considering that these are averages only and that there were undoubtedly many mines running on a small profit, due to high production cost, it is obvious that the profits in others were very much more than the figures would indicate; in fact in July, 1920, during the coal panic, the average profit of one group of companies soared to eighty-two per cent. These same companies one month earlier, under regulation of the Federal Fuel Administration, were earning an average of only fourteen per cent.

High prices during the shortage in that year were attributed by coal propagandists to the practice of the wagon mines. It would appear from the foregoing figures that although the wagon mines may have set the pace, the regular operator was quite willing to follow wherever possible.

With a coal strike in progress and the possibilities of a more or less acute fuel situation before many months confronting the people, one thoroughly appreciates, in the light of the Commission's report, the service rendered by Secretary Hoover in securing the promise of leading operators to follow the prices prescribed by the Garfield Fuel Administration.

Reliability in Hydro-Electric Plant Operation

LARGE steam-electric generating stations are generally located near the center of extensive loads. This has made it possible to place the transmission system underground where the circuits are protected from many of the elements that tend to interfere with the operation of overhead systems. Under this favorable condition many of the large power systems supplied from steam stations have a reliability factor of practically one hundred per cent.

The hydro-electric stations, being generally located a long distance from load centers, have been connected to long, high-voltage overhead systems for the most part. Such systems are subjected to interruptions from lightning, sleet and wind storms and many other more or less minor hazards that do not affect the underground system. These difficulties, especially in the early development of hydro-electric systems, resulted in much adverse criticism of these systems with regard to reliability. However, as they have become more extensive and the duplicate transmission line has become the general rule, with improved equipment and operating methods, the hydro-electric system compares favorably in reliability of service with that rendered by steam plants in large cities and is even better in some cases.

Ice on the transmission lines and in different forms in the water passing to the turbines has always been difficult to contend with. But where duplicate lines are available, a system of heating the lines has been developed that keeps them free from ice and practically eliminates trouble from this source. Probably, preventing the intake works, penstocks and turbines from becoming clogged with ice offers the most serious problem to the operator of the hydro-electric plant. Although it is better understood today than it was a few years ago, it is still of serious moment, and the operators in many plants during the winter months have to be on guard always against the unexpected. A few years ago it was not an uncommon occurrence for ice to put some plants practically out of service at times, but this is rarely the case in present-day practice even under the most severe conditions. If proper attention is given to the design of the intake works in new developments and provision made for heating the racks and turbine casings, there need be little fear of having ice put a turbine out of service. It is in some of the earlier plants that were designed and put into operation before all the factors influencing reliability were understood, that the greatest difficulties lie. However, what these plants lack in proper design is apparently being offset in many installations by operating methods.

Two Important Decisions

IN TWO succeeding weeks the Supreme Court has announced decisions of far-reaching importance to coal users. The first decision, announced on May 29, related to the right of the Government to fix fuel prices during the war emergency. The second, announced on June 5, was an opinion regarding the liability of organized labor with respect to suits for damages and with respect to obstruction of interstate commerce in coal by methods employed during strike periods.

In the first case the court ruled that a coal company was not entitled to damages from the Government because prices fixed for fuel were less than those that it might have obtained if free from price restriction. Thus it seems to be clearly established that in times of emergency when the price of coal may become unreasonable the Government has the right, without recourse by companies affected, to limit the amount that may be charged for this essential of industrial life.

In the more recent decision the court establishes that a labor union recognized in all other particulars as a business entity, with rights and privileges of a business organization, must also assume the responsibility of a business body and, in case of damages caused by its actions, be subject to suit. It is of little consequence that the particular case in question did not involve sanction of the national union and, therefore, did not involve financial responsibility on the part of such union. The fundamental principle is established by this court decision that labor bodies, as well as all other kinds of business associations, must respect property rights or be responsible to property owners for damages caused. This will do much to restrain any lawless element from using strike emergencies as occasion for unwarranted destruction of property.

But from the viewpoint of the coal user the most important point in the entire decision relates to the right of the Government to impose upon every agency engaged in coal production reasonable restrictions. Although coal mining is not interstate commerce, yet, so the Court says, Congress has the power to restrict any activity that would result in direct obstruction to interstate commerce in coal. In other words, this establishes clearly the right of Congress to subject to national supervision and restraint either operator, miner or merchant, who by collusion or otherwise unduly interferes with interstate movement of essential fuel supplies.

The highest tribunal in the land has spoken. Our Federal legislators have the right to determine conditions directly affecting interstate commerce. In time of extreme emergency even price may be fixed by the Government without recourse by those who may thereby lose excessive profits. These decisions establish a splendid foundation for much needed legislation. It will be well for our Congressmen to proceed promptly to build thereon.

Process Steam and the Plant Engineer

THE necessities of power production have compelled power-plant engineers to become experts on the subject of steam. The possession of this knowledge makes their opinions of value in fields lying somewhat outside that of power generation. This is particularly true of the numerous applications of process steam. Moreover, there are many isolated plants in which a large amount of process steam is taken directly from the boilers or from the exhaust of engines and turbines. So the power-plant engineer is not merely trained to have valuable opinions on the subject, but he is also often placed in a position where the use of process steam is closely related to his own job.

Theoretically, he may be responsible only for the production of steam and power. Practically, if he can effect a large saving in the coal bill, whether it come from a better selection of units and control of operating conditions or from better utilization of the process steam, it will redound to his benefit.

Of course no engineer can be familiar with all of the thousand and one uses of process steam. To do so, he would have to be an expert in paper making, textile manufacture and finishing, oil refining, the operation of chemical works of all sorts and so on almost without limit. Two things may, however, reasonably be expected of him. First, that he be trained in the fundamental properties of steam and its action as a means of supplying heat—through coils or by direct contact—to air, water and other liquids and gases under various conditions; second, that he have a fair working knowledge of the particular processes that are using up the steam generated under his direction.

With this equipment he will doubtless have many opportunities, without "butting in" on the work of other men, to help the management in its efforts to reduce the consumption of steam for manufacturing purposes.

In recommending to Congress acceptance of the Ford offer, the Military Affairs Committee did wisely in excluding the Gorgas steam plant. Physically, it is practically a part of the Alabama Power Company's system and its inclusion might have entailed endless litigation. On the other hand, it would be only a minor factor in the Ford project. It is hoped that Mr. Ford will not see fit to press this point, as he might thus defeat the whole proposition.

PRACTICAL IDEAS from PRACTICAL MEN

Pointers for Engineers on Letter Writing

One of the details of engineering that operating engineers do not give the attention to that they should, is the writing of letters. In my opinion, engineers do not as a general rule put much thought or courtesy into their correspondence.

When writing for a catalog, for instance, one should give the name of the company he is employed by, his position with the company and state why he wants the information asked for. It has been my experience that quite often the company you write to for information will send something much better than their general catalog when they know that you are not on the market as a buyer.

To illustrate this point, I recently experienced some difficulty in setting up a certain instrument in a boiler room. I carefully followed all the directions sent with the device, but for some reason failed to get results. I knew that if I could see a similar installation I would be able to trace out my mistake. However, there were none of that type in the city, so I decided to take up my trouble with the makers.

I wrote to the manufacturer, asking for a catalog or literature that would show me some installation of the device and as briefly as possible told them my trouble. Instead of sending me an expensive catalog that would be of no value to me after my trouble was adjusted, they sent me a set of photographs (to be returned to them) showing a number of installations of the device, and I readily saw where my trouble was. Here was a case of the concern knowing more about what I needed than I did myself.

Another detail that we often overlook is the matter of postage. I am personally acquainted with engineers who, if you sent letters to them but failed to inclose postage, would not answer. Yet the same engineers will write for catalogs and other matter and never inclose postage with their requests. One should also bear in mind that when catalogs or information is received, it should be promptly acknowledged.

There is another form of correspondence that engineers find difficult to write and that is an application for a position. Some time ago I advertised for an engineer and received a number of applications, some from men with whom I was personally acquainted and who were well fitted for the job, but their letters certainly did not show it. Here is one of the applications: "Sir: Am leaving my present job the last of this week. I hold an engineer's license. Am married, can do piping and make general repairs. Let me know at once when you will want me." In the first place he takes it for granted that the job is his, but tells nothing about himself of interest to a prospective employer.

My suggestions to those writing letters of application for positions are as follows:

Don't make your letter too long; a business man has not the time to read it, nor is he interested in your life history. Give your last five years' experience. If you have nothing to show for the last five years, you never will have. Don't brag; if you offer more than you can give, you will slip on the job at the start. Give at least three references and make them local, if possible, as references from a man in Japan, with the job in Boston, are of little value.

Fall River, Mass. ARTHUR D. PALMER.

Cheap Help Regardless of Results

I stopped at a railroad roundhouse recently and had a chat with the "engineer." This plant consists of two medium-sized boilers, hand-fired with anthracite. The man in charge is of foreign birth who cannot even read the inspection certificates on the wall. He operates these boilers, two engines, a boiler-feed pump of the outside-packed plunger type, and the boilers are required to heat the necessary buildings.

The required pressure is 125 lb. gage. When the steam gets down to about 75 lb., this man opens the blowers wide and proceeds to fire up by throwing about a half ton of coal in each door, and as there are four doors he sure heaves some coal. He leaves the doors all open and then shuts them all at once. As soon as he has his steam up to the popping point, he opens the pump throttle wide and fills the boilers up to the top of the glass. By the time this is done, he has his steam down to 75 lb. and has to go to it all over again. As there is no license in this town, he gets away with it.

I fail to see why he couldn't keep an even steam pressure with an even feed if he was a real engineer. He has been at this job, so he informed me, for seven years. He says that on a cold day he cannot keep the boilers warm and when he washes out one and throws the load onto the other he has to work real hard. Why wouldn't he with such methods? The railroads are laying off men all the time for the sake of economy and

letting such halfway methods get by simply because they are too short-sighted to pay a real engineer his price.

As everyone knows that has fired hard coal, the main thing is to keep an even, level fire. This man has a fire that puts the Rocky Mountains to shame. It is full of holes and these he covers up; on the "hills" he places more coal. He has a leveling bar, but never uses it. In spots his fire has clinkers a foot thick and in other places it has none, and these places make the holes. With forced draft he wonders why his tubes are all the time leaking.

If he would level off his fire every time before he fires up, he would find the saving in labor worth while.

Syracuse, N. Y. R. G. SUMMERS.

Coal Elevator as a Coal Weigher

The coal inventory of our plant for 1920 did not check within 5,000 tons of the estimated amount used, so the importance of a means for weighing the coal was forcibly brought forward.

The coal was spouted directly from the bunkers to the stoker hoppers. As there was not sufficient headroom to get in a weighing larry, or automatic scales, a car that would run on a track on the boiler-room floor with scales and a small elevator to deliver the coal to the stoker hoppers after it was weighed, was considered. However, it was not desirable to invest much money in any equipment that could not be utilized later in a new plant.

The coal-handling layout is shown in Fig. 1. All the coal passes through the crusher to the elevator, which elevates it about 68 ft. and delivers to a flight conveyor that distributes it to the bunkers.

It occurred to me that a measure of the power taken

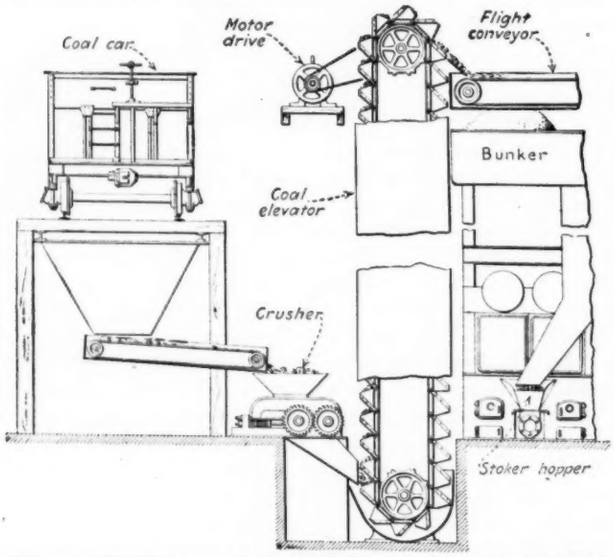


FIG. 1. GENERAL ARRANGEMENT OF COAL HANDLING EQUIPMENT

to elevate the coal, together with a record of the total revolutions of the elevator, might give a measure of the coal consumed. Accordingly, a kilowatt-hour meter was installed on the motor leads and a revolution counter on the elevator head shaft.

A curve-drawing wattmeter gives a curve like Fig. 2 when the elevator is in operation, the valleys in the curve representing the load when the coal hopper runs empty or coal feed to the elevator stops from any cause. The line *AB* represents the power curve with the elevator running light, or the friction load. The watt-hour meter records the total area of the curve above the line *CD*. The area above the line *AB* represents the net power required to elevate the coal and should be proportional to the weight of coal elevated in that time. The area *CDBA* is directly proportional to the number of revolutions of the elevator headshaft, the motor efficiency from friction load to full load being nearly a straight line.

The friction of the elevator loaded is of course greater than when running light, but if the increase in

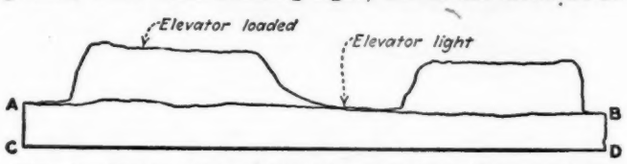


FIG. 2. SHOWS LOAD CURVE DRAWN BY WATTMETER ON MOTOR CURRENT

friction is proportional to the weight of coal elevated, then the total kilowatt input minus the kilowatt input for no load corresponding to that number of revolutions taken to elevate the coal, is proportional to the weight of the coal delivered to that bunker.

The elevator was calibrated by elevating known weights of coal. The friction (or "tare kw.") was measured at various times by counting the revolutions of the wattmeter dial for a given number of seconds. Most kilowatt-hour meters have a constant marked on the dial, from which the kilowatts per hour is found, which in this case was

$$Kw.\ (for\ one\ hour) = \frac{3{,}600 \times revolutions \times constant}{Time\ for\ revolutions\ (in\ seconds) \times 1{,}000}$$

It was found that one net kw.-hr. (gross kw.-hr. minus tare) would elevate 16.87 tons of coal. It was also noted that a gross kw.-hr. put up 9.44 tons of coal, and that 1,000 revolutions of the headshaft put up 15.31 tons of coal.

The readings for one month were as follows: gross kw.-hr., 288.3; tare kw.-hr. (corresponding), 126.8; net kw.-hr., 161.5; revolutions of headshaft, 177,538. From the net kilowatt input the total weight of coal was $161.5 \times 16.87 = 2{,}725$ tons. From the gross kilowatt input $288.3 \times 9.44 = 2{,}722$ tons, and from the total revolutions of headshaft $\frac{177{,}538}{1{,}000} \times 15.31 = 2{,}718$ tons, or a difference between the three ways of computing of less than 1 per cent, an error probably much less than that due to the varying percentage of moisture in the coal.

The elevator was oiled in the routine way. Some coal cars were frozen, and this frozen coal jammed the feeder conveyor at times. Some cars had boards and timbers in the hopper bottoms, put there at the mines to prevent leakage in transit, and these also jammed the feeder occasionally, but with these variations in the feeding a fairly accurate weight of the coal consumed is obtained.

If you should ask the man who runs the conveyor how much coal is in the bunkers at any time, he would probably look bewildered, but if you ask him how long, running steadily, it will take him to fill the bunker, he can tell you to a few minutes, and that is how the coal in the bunker is inventoried at the end of the month.

Lansing, Mich. J. R. BELKNAP.

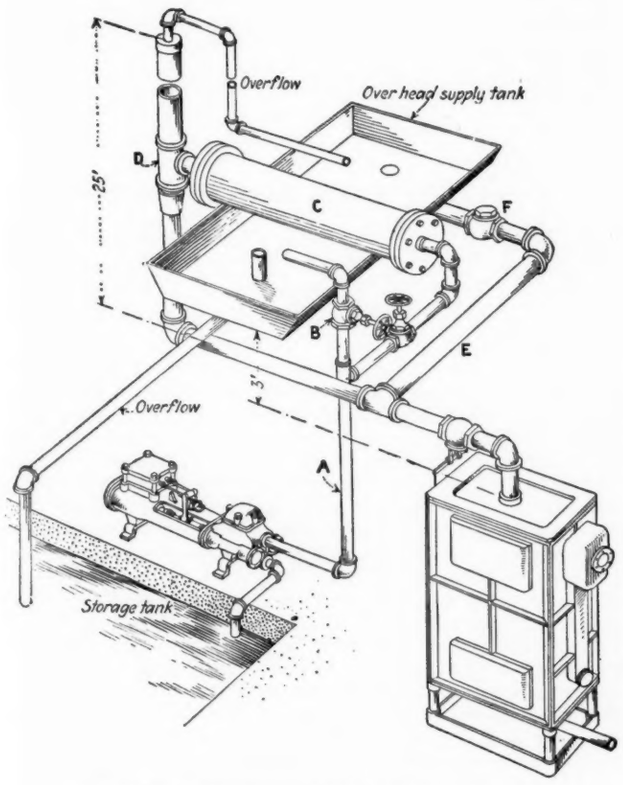
Increasing Head on Water Supply to Heater

The feed-water system of our plant was originally laid out with a heater located in the boiler room and supplied with water from a tank on the roof of the building. The water was first pumped to the supply tank from a reservoir outside of the building and then flowed by gravity to the heater.

During the last few months we had considerable difficulty in keeping the heater supplied with water at peak-load periods. The feed pump would draw the water from the heater faster than it would flow from the overhead tank. Cold water then had to be taken direct from the storage tank. We finally decided that the trouble was caused by the low head of the water supply and the increase in exhaust steam, passing to the heater, due to the operation of a turbine-driven centrifugal pump recently installed.

As the supply tank was only three feet above the top of the heater, when the water level went down in the heater, it would fill with steam and produce a back pressure, thereby lessening the flow of water from the tank.

To overcome this trouble, changes in the feed system were made as shown in the cut. A connection was



GENERAL ARRANGEMENT OF HEATER AND WATER SUPPLY SYSTEM

taken off the discharge pipe *A* at a point below the valve *B* and connected through the 12-in. storage pipe *C* to a standpipe *D* which was fitted with an overflow at the top and connected at the bottom to the original supply line *E*.

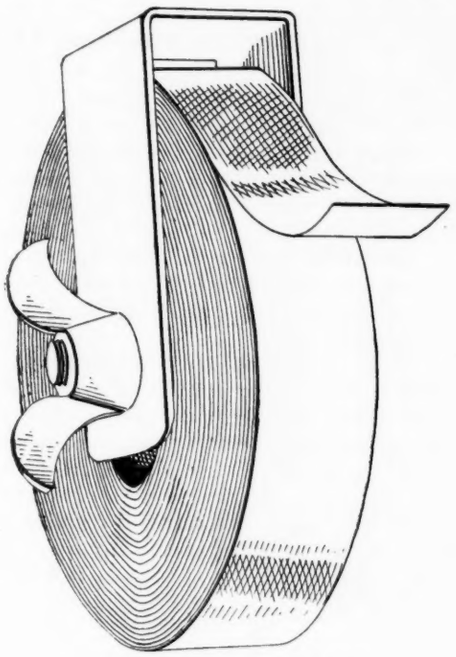
As the standpipe is 25 ft. high, there is sufficient pressure to keep the heater supplied at all times. Should the pump stop and the water level in the standpipe fall, the check valve *C* would open and water would flow to the heater as formerly. This system is now in operation and giving good results.

Sanford, Fla. C. H. McMAHON.

Reinsulating Field Coils

Burned-out series-field coils that are composed of a small number of turns of comparatively heavy cotton-covered wire may be reclaimed in the following manner:

The old cotton covering of the wire is burned off, and the coil, with the insulation thus removed, is dipped



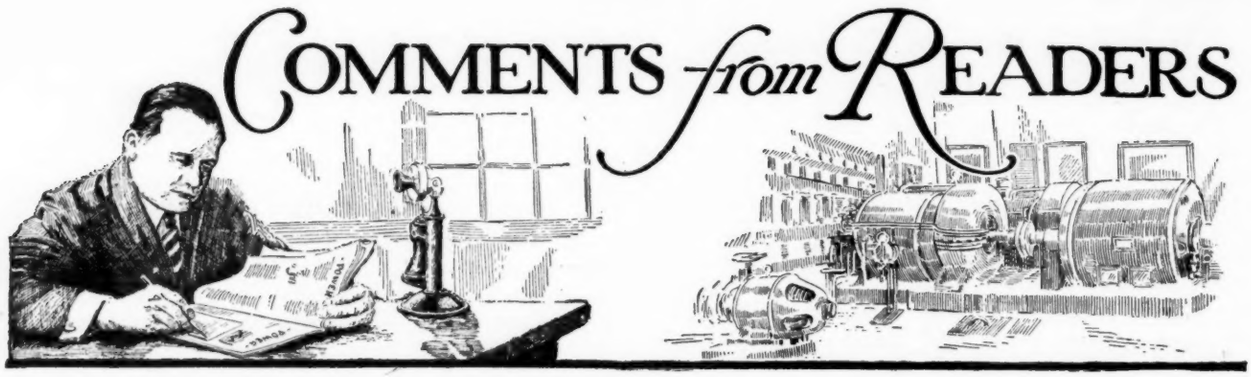
CLAMP ON ROLL OF TAPE

into a pickle bath to clean it. This cleaning is supplemented by separating the turns by stretching the coil like a spiral spring on a horizontal bar and going over the full length of the wire with sandpaper. After it is wiped off thoroughly, the coil is ready for reinsulating by hand. It is stretched along the horizontal bar again, and linen tape is half-lapped the full length of the wire. While the tape is being applied, it must be maintained taut so that a tight and uniform covering may be obtained. The little clamp illustrated in the figure is useful in controlling the tape to apply it tightly, uniformly and conveniently.

The operator holds tape and holder in one hand and steadies the wire with the other. The thumb-nut of the holder is drawn just tight enough to permit the tape to slip through when being applied with the proper tension. After the insulating of the wire is finished, the coil is suspended at a convenient height, then a few of the turns are released and brought down onto a form the size of the polepiece after an allowance has been made for the thickness of the insulation that is to be applied to the coil as a whole. The turns are put into place around the form, their length being suggestive of the order in which they should be handled.

After some experience a high degree of skill is acquired in placing the turns so as to make a good job.

Brooklyn, N. Y. E. C. PARHAM.



Important Use for Boiler-Tube Cleaner

The article in the April 11 issue, "Boiler-Tube Cleaners Have Many Uses," failed to mention an essential service; namely, the dislodging of soot as well as scale.

Every well-equipped plant provides some method for the removal of soot. But, however successful such method may be, a certain amount of soot is sure to accumulate on the tubes in the form of a hard, tenacious layer, against which blowing or scraping has no effect. Such a layer of soot may be removed easily and thoroughly by employing a cleaner that sets up a vibration in the boiler tube.

If the soot is on the inside of the tubes, such as in return-tubular boilers, the cleaner may be run rapidly through the tubes, dislodging the soot, before attempting to remove the scale from the outside of the tubes. In water-tube boilers, the two operations are accomplished at one time. The removal of scale by rapid vibration of the boiler tube applies equally well to incrustation inside or outside of either straight or curved tubes.

W. HARRIS DAY.

Buffalo, N. Y.

Circulating Oiling System

In the May 9 issue, W. F. Osborne gives some of the advantages of the circulatory or circulating oiling system. This system gives greater economy by the reduction in the amount of oil consumption. This is accomplished both by maintaining a lower bearing temperature which reduces evaporation losses, and by the reclamation of the oil after passing through the bearings. Greater economy is also obtained by decreasing the friction and bearing wear, because the bearing always has sufficient oil to maintain a perfect oil film, if the journal and bearing are in good condition.

But few of the older engines are equipped with the circulating oiling system. Hence the system that has been installed on our engines and has given good service may be of interest.

The engines were originally fitted with sight-feed glass drip cups. These were drilled in the top cover for the entrance of a small brass pipe fitted into the drip cocks. Quarter inch black pipe was used to run to the cup groups. One connection was made to the crankpin, one to the main bearing, one to the outboard bearing and one to the guides and crosshead. One or more drip cocks were fitted to each of these branches as required for the number of oil cups used. A ¾-in. supply line was used from the branches to the supply tank, which is located three feet above the level of the highest cup.

The supply tanks have a capacity of ten gallons each. We have found that a tank having a large surface area gives the best results, owing to less variation in head for a given quantity of oil run through the system. The oil runs from engine bearings and crank case to a filter in the basement of the engine room, and a belt-driven pump is used to pump the oil into a second filter on the engine-room floor, from which it is drawn to refill the engine supply tanks, located about ten feet above the engine-room floor.

The original glass sight-feed cups were retained, and the oil from the drip cups is adjusted to give the desired amount of oil; the drip cocks on the supply lines are then adjusted to keep the oil cups filled about three-fourths full, which will keep the bearing oiled for considerable time should the flow of oil stop or decrease, owing to variation in the head on the supply lines or any other cause.

W. K. HERVEY.

Lindsborg, Kan.

Operating Alternators in Parallel

I noticed in *Power*, May 16, 1922, page 789, an article by Albert Bankes entitled, "Why Cannot the Generators Be Connected in Parallel?" His problem can be solved by quoting in part a passage in Pender's Handbook, as follows:

In the operation of an alternating-current generator the following factors should be considered: When a third harmonic is present in the e.m.f. wave of the three-phase generator, the triple frequency e.m.f.'s in the three phases (or windings) are additive when the three phases are connected in Δ; that is, the Δ forms a short-circuit to the third harmonic e.m.f.'s, and a large triple frequency current may therefore be set up in the windings irrespective of the load on machine. On this account large three-phase generators are usually Y-connected, since with this connection the third harmonic e.m.f.'s between any two terminals of the machine neutralize each other. However, when two or more Y-connected machines are operated in parallel with their neutrals grounded, a triple frequency cross-current of considerable magnitude may be set up between the machines, unless the wave forms of the e.m.f.'s of the various generators are exactly the same, which is practically never the case. To prevent such cross or circulating currents with Y-connected machines with grounded neutral, it is the usual practice to ground the neutral of but one generator at a time. Provision must of course be made to shift this ground connection from one machine to the other, so that a ground connection can always be maintained irrespective of which machine or group of machines may be running.

The reason that Mr. Bankes has no trouble when using the 33,000-volt bus alone is probably because the 7,500-kva. transformers can dissipate the circulating currents.

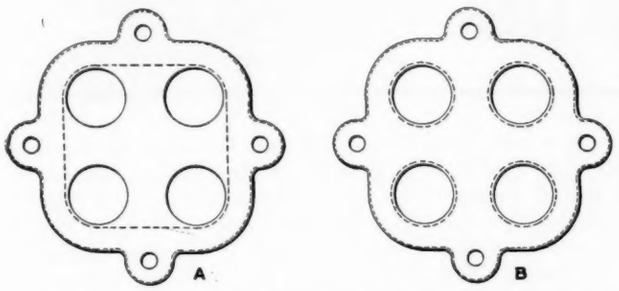
HENRY B. DROWNE.

Brooklyn, N. Y.

Trouble-Hunting Suggestions

I read with interest the article by N. L. Rea on "Trouble-Hunting Suggestions," in the April 4 issue, and I recall an experience I once had with a duplex boiler-feed pump.

We had two pumps, and it became necessary to move them to new foundations. No. 1 pump was overhauled and installed in the new location and put in operation.



THE IMPROPER AND PROPER WAYS OF CUTTING PUMP GASKET

We then overhauled No. 2, but on starting it up neither piston would reverse until it struck the cylinder head. We had the steam valves refaced and worked several hours trying to set them properly, and finally had the pump operating so that only one of the pistons struck the end of the cylinder. We then shut down No. 1 pump and tried No. 2. It was soon apparent that the pump was not delivering much water and that the trouble was in the water end of the pump instead of the steam end.

Upon removing the valve chamber cover, we found that the gasket between the outlet and the inlet valve chambers and the connection to the cylinder had not been properly cut, as shown by the dotted line at *A*, and the water had been passing from one end of the cylinder to the other. A new gasket was cut as shown at *B* and our trouble with the pump was over.

Citronelle, Ala. G. W. BRUSH.

Chattering of Brushes

In the April 18 issue H. W. Rose gives his theory on the elimination of brush chattering by boring a hole in the center of the brush face. His first observation, that the drilling reduces the contact surface of the brush, thereby increasing the pressure, seems to be correct, but if insufficient brush pressure were the only cause of the chattering, an increase in the spring tension should accomplish the same result. He states that the rotating commutator tends "to fan all the air out of the hole in the brush," thereby increasing the pressure of the brush against the commutator. In my opinion the air between the commutator segments would be thrown outward by centrifugal force, and would tend, if anything, to compress the air in the hole and force the brush away from the commutator.

If the brush was loose in the holder, it might chatter sufficiently to wear the outer edges faster than the central portion. This would cause a poor fit on the commutator.

A hole drilled in the center would tend to reduce the area and increase the wear of the central section of the brush. This would counteract the tendency for the edges to wear faster than the central section. The brushes would then fit the commutator better, and the liability to chatter would be reduced. The real remedy in this case, however, would be to provide a brush that would properly fit the holder. D. R. DE TAR.

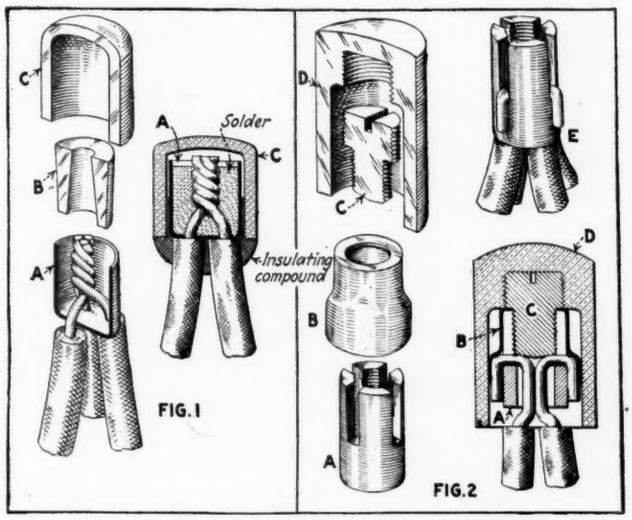
Manhattan, Kan.

Making Splices in Electric Wires

I read with much interest the article of Mr. Phillips in the April 4 issue of *Power* describing his methods of splicing wires. Figs. 1 and 2 show two entirely different ways of connecting wires in junction boxes, which we apply universally in Holland. We never use a blow-torch for soldering the joints, but a special small alcohol lamp, which is convenient, especially when working in corners or along the ceiling.

Fig. 1 shows a standard splicing method. The brass receptacle *A* is pushed over the wires, which are usually twisted together beforehand, unless there are two or more holes made in the receptacle instead of one, as in the figure. Then the solder bushing *B* is inserted and the flame of the soldering lamp directed against the brass receptacle, causing the solder to melt. After the joint is made, it is covered by a porcelain insulating shell *C*, which is fastened by means of insulating compound. In order to prevent cracking, the finished joint, shown in section Fig. 1, is pushed back into the junction box before the compound gets hard. This method is approved by all the electric utilities, and the use of tape in junction boxes is now prohibited.

A method of making splices without soldering is shown in Fig. 2. The wires are put into the slotted



FIGS. 1 AND 2. CONSTRUCTION OF WIRE-SPLICING DEVICES

brass sleeve *A* and bent back over the bottom of this sleeve as indicated at *E*. A brass bushing *B* is pressed over the bent wires and tightened by the screw plug *C* in order to make proper contact between the wires and the bushing *A*. The insulating shell *D* is threaded on the inside at the top and is screwed to the upper part of the plug *C*. A section through the complete joint is shown in the figure. No insulating tape or compound is required, and the wires are easily taken apart without injuring them. H. WIELAND LOS.

Schoonhoven, Holland.

QUESTIONS AND ANSWERS

Heating Surface of Return-Tubular Boiler

What is the number of square feet of heating surface in a horizontal return-tubular boiler 18 ft. long and 5 ft. in diameter containing 48 tubes, 4 in. in diameter and 18 ft. long? S. O.

The heating surface of a return-tubular boiler consists of the area of the cylindrical shell and heads and of the tubes, exposed to the direct heat of the fire, or to the heated gases. Depending on the character of setting, ordinarily this means one-half of the shell and the inside area of the tubes, together with about two-thirds of the area of each flue sheet less the area taken out by the tube holes; and as boiler tubes are sized according to their external diameter, for greater convenience in calculation the usual rule is to consider their external instead of internal diameter.

The dimensions 18 ft. long and 5 ft. diameter would be equal to 216 in. long and 60 in. diameter.

	Sq. In.
One-half of the shell circumference = ½ of 60 × 3.1416 = 94.25 in. Hence heating surface in shell = 216 × 94.25 =	20,358.0
Having tubes 4 in. in diameter, the circumference of a tube is 4 × 3.1416 = 12.566, and 48 tubes, each 18 ft. long, would make heating surface of all tubes = 48 × (18 × 12) × 12.566 =	130,284.3
The gross area of one tube sheet is 60 × 60 × 0.7854 = 2827.4 sq.in. ⅔ the area = ⅔ of 2,827.4 = 1,884.9 sq.in.	
The cross-sectional area of one 4-in. tube hole (neglecting the tube thickness) is 4 × 4 × 0.7854 = 12.566 sq.in. and 48 tube holes would have total area of 12.5668 × 48 = 603.2 sq.in.	
Hence the net heating surface in one tube sheet would be 1884.9 — 603.2 = 1,281.7 sq.in., and for 2 tube sheet = 1,281.7 × 2 =	2,563.4
Therefore the total heating surface in square inches would be	153,205.7
or 153,205.7 ÷ 144 = 1,063.9 sq. ft.	

Superheated Condition for the Reduced Pressure

Is steam superheated after it passes through a pressure-reducing valve? J. E. S.

In passing through a pressure-reducing valve a small part of the heat of the steam is lost by radiation and part of the heat of the steam is temporarily converted into the work of overcoming friction and imparting velocity to the steam. The work is reconverted into heat when the steam velocity is checked on the low-pressure side of the reducing valve, so that practically the total heat contained in each pound of the initial steam is retained after it has been delivered to the low-pressure side of the valve. As the heat contained by a pound (weight) of dry saturated steam at higher pressure is more than the heat contained by a pound (weight) of dry saturated steam at a lower pressure, it follows that by discharging dry saturated steam of higher pressure through a pressure-reducing valve, each pound will contain more heat than a pound of dry saturated steam at the lower pressure and therefore will be in a superheated condition for the lower pressure.

As an example, suppose steam at 150 lb. gage, in passing through a pressure-reducing valve, is reduced to 20 lb. gage. By referring to a table of properties of steam, it may be seen that a pound of dry saturated steam at the pressure of 150 lb. gage, or 165 lb. per sq.in. absolute, contains 1,195 B.t.u. above 32 deg. F., and that a pound of dry saturated at the pressure of 20 lb. gage, or 35 lb. per sq.in. absolute, contains 1,166.8 B.t.u. above 32 deg. F. After passing through the reducing valve, each pound of the steam would contain 1,195 — 1,166.8 = 28.2 B.t.u. more than necessary for saturated condition at the reduced pressure. Consequently, the temperature would be higher than the temperature of dry saturated steam at 20 lb. gage, or 35 lb. per sq.in. absolute, which is 259.3 deg. F. By referring to a table of properties of superheated steam, it may be seen that when steam at that pressure has a temperature of 309.3 deg. F.—that is, superheat 50 deg. F. above the dry saturated temperature—each pound contains 1,191.3 B.t.u.; and when the temperature is 319.3 deg. F., or there is 60 deg. of superheating, the heat content is 1,196.1 B.t.u. Hence to contain 1,195 B.t.u. the superheating would be between 50 deg. F. and 60 deg. F. above the temperature of dry saturated steam at the reduced pressure.

Electric Service for Stated Cost

We purchase electric power for part of our load at the following rates: First 200 kw.-hr. at 5c.; next 300 kw.-hr. at 4c.; next 500 kw.-hr. at 3c.; next 300 kw.-hr. at 4c.; next 500 kw.-hr. at 3c.; next 1,000 kw.-hr. at 2½c.; next 3,000 kw.-hr. at 2¼c.; next 5,000 kw.-hr. at 2c. How much can be obtained for a charge of $100 at these rates? M. D.

The charges are cumulative, that is,

First 200 kw.-hr. at 5c	$10.00
Next 300 kw.-hr. at 4c	12.00
Total 500 kw.-hr.; total charge	$22.00
Next 500 kw.-hr. at 3c	15.00
Total 1,000 kw.-hr.; total charge	$37.00
Next 1,000 kw.-hr. at 2½c	25.00
Total 2,000 kw.-hr.; total charge	$62.00
Next 3,000 kw.-hr. at 2¼c	67.50
Total 5,000 kw.-hr.; total charge	$129.50

The quantity for $100 would be more than 2,000 kw.-hr. for a total charge of $62 and less than 5,000 kw.-hr. for a total charge of $129.50, and the amount coming between those quantities would be chargeable at the rate coming next after the rate for 2,000 kw.-hr.; namely, 2¼c. per kw.-hr. After service of 2,000 kw.-hr. for $62, the unexpended balance would be $100 — 62 = $38, which at the 2¼c. rate following 2,000 kw.-hr. would purchase $38 ÷ 0.02¼ = 1,688.8 kw.-hr. additional. That is, 2,000 kw.-hr. for $62 and 1,688.8 kw.-hr. for $38 would make a total of 3,688.8 kw.-hr. for a total charge of $100.

The foregoing does not apply where there is a maximum demand charge to be made.

Vernier Readings

How is a vernier scale divided and used for reading fractional values of parts of a main scale? B. H. J.

In the figure the short graduated scale *a b* is a vernier made to slide along a fixed scale *A B* so that the graduations of both may be compared. The fixed scale *AB* being divided into equal parts, the whole length of the vernier *a b* may be taken to equal nine of these parts, and is itself divided into ten equal parts.

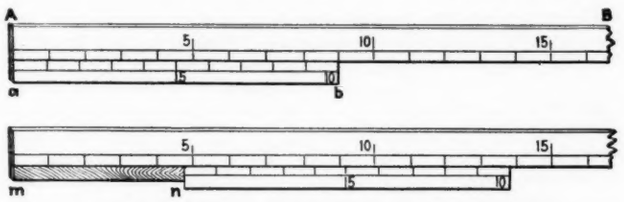


ILLUSTRATION OF VERNIER AND READING

Then each of the parts of the vernier *a b* will be equal to nine-tenths of a part of the main scale; that is, each vernier part will be less than a part of the main scale by one-tenth of the latter.

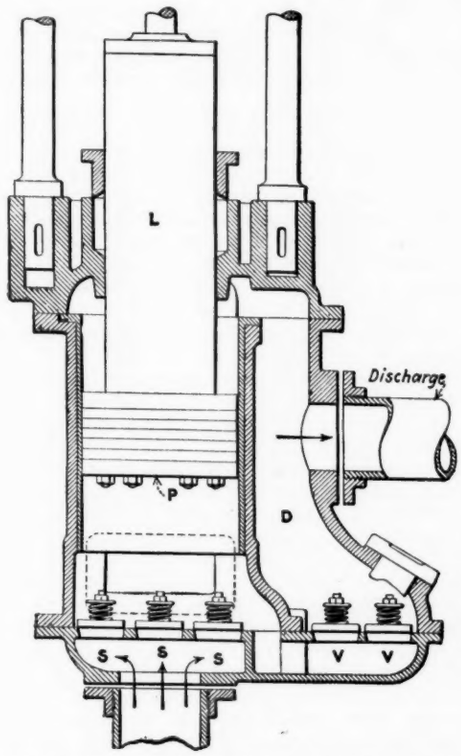
In order to measure the length of any object *mn*, suppose the latter, when placed as in the figure, has a length greater than four but less than five parts of the main scale. To determine the fraction of a main scale part that *mn* exceeds four whole parts, one of the ends *a* of the vernier *a b* is placed in contact with the extremity *n* and the division on the vernier is sought that coincides with a division of the main scale. In the figure this coincidence occurs at the eighth division of the vernier, counting from the end of *n*, and indicates that the fraction to be measured is $\frac{8}{10}$ of a part of the main scale *AB*. As each of the parts of the vernier is less than a part of the main scale by $\frac{1}{10}$ of the latter, it is evident that in proceeding toward the left from the point of coincidence, the divisions of the vernier are respectively one, two, three, etc., tenths of a main scale part ahead of the nearest following divisions of the main scale. Hence, when the 8th division is coincident with a division of the main scale, the zero division of the vernier will be $\frac{8}{10}$ of a main scale part ahead of the last complete part of the main scale, and the whole measurement of *m n*, as illustrated, would be 4.8 parts of the main scale. In place of tenths, the vernier scale in the same manner may be spaced to read any other fraction of a part of the main scale. For reading hundredths of a main scale part, one hundred parts of the vernier would be made equal in length to 99 parts of the main scale, or in fact for reading to sixteenths or any other fraction of a main scale part, the number of parts of the vernier would be equal to the denominator of the fraction and the total length of the vernier would be equal to one less number of parts of the main scale.

Differential Plunger Pump

How is the steady discharge obtained from a differential plunger pump that is provided with suction valves for only one end of the working cylinder? J. H. A.

This type of pump is also known as a "piston and plunger pump." One-half of the suction water received in one end of the cylinder is discharged to the other end of the cylinder from which it is discharged during the suction stroke, thus making the discharge nearly continuous, as may be understood from the illustration, which gives a sectional view of such a pump arranged for use vertically, as a sinking pump for mining.

All the suction lifting of the water is performed during the upward movement of the piston *P* by water entering through the suction valves *S S S*. When the piston descends, all the water below it is forced through the valves *V V* into the delivery chamber *D*, in this respect operating as a single-acting pump. But during the downward movement of the piston the plunger *L* like a piston rod is entering the upper part of the pump



SECTIONAL VIEW OF VERTICAL DIFFERENTIAL PUMP

cylinder through a stuffing box. The plunger is made one-half of the cross-sectional area of the cylinder, so that during the downward stroke one-half of the water delivered to the chamber *D* is discharged by the pump and one-half is delivered to the space above the piston from which it is displaced and is forced back into the delivery chamber upon the next upward stroke of the piston. There is discharge from the pump during the upward stroke as well as during the downward stroke, for the valves VV as well as the suction valves open but once during a double stroke of the pump.

Hydraulic Works To Relieve Ice Troubles*

Ice Troubles Inside the Power House—Works To Take Care of Ice Troubles Outside the Power House—Suggestions for Operating Hydro-Electric Plants During Winter Months in Cold Climates

DURING the early days of hydro-electric developments it was quite common to hear of serious interruptions of the electric service in cities and towns due to waterwheels and canals being clogged with ice. In those days few engineers had a clear conception of the underlying causes of ice troubles. During the last fifteen years, however, a great deal of time and money have been spent in connection with this important problem by hydro-electric plants located in countries having cold climates, and as a result a point has been reached where, with a fair amount of success, the designer of a power plant can either provide means to eliminate ice troubles entirely or lay out intakes, racks and water passages in such a way that the ice can be disposed of without seriously interfering with the successful operation of the plant. There is, of course, no universal cure for all kinds of ice trouble; each case must be treated separately.

John Murphy, of Ottawa, has made valuable contribution to our knowledge of ice problems, particularly with reference to combating frazil ice. He has successfully demonstrated the possibility of reducing troubles from frazil and anchor ice in the power plants by the means of applying a small amount of heat to racks and wheel casings. In this connection, by raising the temperature of structures and machine parts a few thousandths of one degree above the temperature of the frazil and anchor ice, the ice will not stick and clog up the water passages.

Ice Trouble in the Power House

In modern low-head installations where the openings between the guide vanes are large, and particularly in plants where vertical single-runner units are used, the usual method adopted today in combating frazil ice is to lift or remove all or part of the screens and allow the ice to pass through the runners. This method of operation has been adopted among many others by the Pennsylvania Water and Power Co. at Holtwood, Pa., and the Cedars Rapids Manufacturing and Power Co., at Cedars, Quebec, with almost complete success.

In removing the racks the water passages are usually so large that frazil and small sheet ice has no chance of clogging the openings. Considering the fact that runs of frazil ice, as a rule, last only for a few hours at the time, there will usually be a sufficient amount of heat stored in the concrete scroll cases to prevent the ice from sticking. Head covers, shafts and guide-vane stems are, in case of single-runner vertical units, as a rule in contact with the warm air in the power house, and enough heat is transmitted to prevent the ice from seriously sticking to these parts.

In plants where horizontal-type units are built into an open flume, or where vertical type units with small openings are used, it has been found that by heating the racks and other metal parts with a small amount of steam or hot water the units can be kept in continuous operation. Waterwheels have also been built with arrangements for heating the speed-ring vanes with hot water. In high-head plants ice trouble is usually limited to intakes and racks. The wheel casings are, in this case, as a rule, in contact with the warm air in the power house.

Heat in the form of steam is usually supplied to the metal parts from small stationary steam boilers or dinkey engines. In some plants the boiler is kept ready for contingencies during the entire winter. The nature of the requirements for steam is such that under condition of high fuel cost or in remote localities operating companies may find it advantageous to consider the installation of an electric boiler. Electric boilers have been built in sizes from 100 hp. to 25,000 kw. at a remarkably low cost. A boiler of this type can be brought up to full steam pressure in a few minutes.

Electrically heated racks have been installed in some plants, but as the installation is rather expensive this method has not been adopted to any large extent.

In plants where the racks are not located inside of a heated building, some operating companies have found it advisable to lag the racks above the water level and to install steam pipes between the lagging and the racks.

Where the racks are inside the gatehouse building, an arrangement for supplying heat to the top of the racks has proved quite successful. Hot air from an electric heater is blown by means of a fan through ducts down against the top section of the racks.

Various kinds of mechanically operated ice skimmers are in use for the purpose of removing small floating ice inside of the gatehouse.

The intake racks at Cedars, Quebec, are made in two sections, the top section being supplied with two 1¼-in. plough-steel cables for the purpose of quick removal in case of a sudden run of frazil. The gatehouse crane has sufficient capacity to pull the top racks against the full hydrostatic head. The headgates are also in two sections, the top section being operated by means of a screw and the bottom section by means of wire ropes wound over a drum. The bottom sections of the gate can be pulled only after the wheel case is full of water and the pressure equalized on the two sides of the gates. With this arrangement of gates and racks, it has been found that the full load can be obtained from the units even during the most severe run of ice.

In summing up experiences gained by companies from operating hydro-electric plants in cold climates, the following recommendations may be of interest to designing and operating engineers:

1. Locate the headgates and racks in a heated room and prevent cold air from getting in contact with the racks.
2. Arrange the racks so that they can be easily pulled. The section of the intake from which the racks are removed must have sufficient area to allow the water to enter the penstocks and wheel casings without too much disturbance. Keep in mind that frazil ice is easily formed where the water is greatly disturbed.
3. Provide means for quick removal of racks.
4. Provide steam or hot-water equipment for supplying heat to metal parts of turbine.
5. Keep proper record of the temperature of the water during the winter season.
6. Keep proper record of intensity and direction of the wind. Frazil ice is often formed in open stretches of the river with heavy wind blowing.
7. Keep in mind that frazil ice will often give more trouble during comparatively mild winters than during more severe ones.
8. Instruct and train the operating force to take precautionary measures before the ice has clogged intakes and wheels rather than to fight the ice after the plant is shut down.

Ice Trouble Outside the Power House

Most hydraulic engineers agree that ice troubles will be practically eliminated provided the intake canal and the river above the intake have a sufficiently thick coating of ice to prevent frazil and anchor ice from being formed. This is undoubtedly true provided the river is frozen for a sufficient distance to prevent any frazil and anchor ice formed in the rapids and open stretches of water from reaching the power canal and building up underhung dams. The great majority of plants in the North are not so fortunately situated. It is, therefore, as a rule, necessary

*Abstract from N.E.L.A. Hydraulic Power Committee's Report, 1922.

to provide means for getting rid of the ice when it reaches the power works, One of the hardest problems to solve today is that of preventing floating sheet ice, and very often floating sheet ice and a combination of frazil and anchor ice, from entering the power canal, and clogging the canal either entirely or sufficiently to reduce seriously the head on the plant.

This problem has been solved in many cases by means of ice-deflecting booms. As an illustration may be taken the ice boom recently installed by the Niagara Falls Power Co. In the case of this company, a floating boom has been installed parallel to the flow of the river. The boom, which is chained to concrete piers, prevents floating ice entering the power canals. The velocity of the water underneath the booms is kept very low. For this purpose a channel has been dredged out between the main power canals and the booms. Any sheet ice being sucked under the boom and into the power canal is removed in the gatehouse by means of mechanically operated rakes and an ice skimmer (electrically operated conveyor.)

In the case of Cedars the canal must be kept open all winter by means of ice breakers on account of the heavy flow of sheet ice, frazil and anchor ice. It has so far been impossible to keep the ice out of the canal, although the chief engineer of the company expects before long to provide means whereby most of the ice may be deflected into the main river channel. The present method of handling is to prevent the surface ice from forming in the canal, and to allow any ice entering the canal to be passed through large sluices provided for this purpose. Since there is no shortage of water in the St. Lawrence River, this method has been found successful.

The Cedars company has at times found it necessary to resort to blasting of ice jams, and for this purpose uses an explosive made from ammonia nitrate having a strength equivalent to 30 per cent nitroglycerin dynamite. The sticks are three inches in diameter and eight inches long. This explosive gives a large gas volume and is slow in action. It does not freeze until the temperature reaches five below zero and, if left in the water for about an hour, dissolves and consequently is not dangerous.

A source of trouble that often gives the operating force of a power plant considerable extra work is the freezing up of sluice gates. To obviate this trouble, it is now quite common to lag the gates and install steam or electric heaters between the lagging and the skin plate. With the gates properly lagged, very little heat is required to keep the ice from adhering to the gates. One company has found that a 5-kw. heater will keep a gate 40 ft. by 20 ft. free from ice. Before these gates were lagged and heaters were installed, a barrier of ice would sometimes form in front of the gates of sufficient thickness to hold back the water after the gates were removed.

Headgates have also been kept free from ice by means of emitting compressed air from pipes laid in front of the gates, approximately at the sill level. This method makes use of the slightly warm water near the bottom of the river to melt the surface ice.

The rolling dam, which to a great extent is used in the northern part of Europe, has been found easy to operate under all kinds of ice conditions. This type of gate is easily heated and may be furnished with ice-cutting gears. When opened, the gate moves away from the ice, which is another feature in its favor.

Stoker Repair Parts

Ordinarily, when a part for an automobile has to be replaced, the owner goes directly to the manufacturer for spare parts, thereby being assured that they will be well made and properly fitted. This also holds good when purchasing spare parts for turbines and generators. Unfortunately, due to the general belief that a casting is a casting as long as it is well finished, there has grown up a tendency to discard the fitness of such a casting when purchasing to replace a worn out or destroyed part of a stoker.

"The stoker manufacturers," says P. A. Poppenhusen, president of the Green Engineering Co., "appreciate that with the present high freight rates they cannot compete with local foundries in the cost of small repair parts. It should be appreciated by the public, however, that accurate fit of all parts in a mechanical stoker is just as important as an accurate fit of parts for any other piece of machinery, and the purchaser should well afford a price which, owing to present freight rates, may seem high compared with local quotations."

"Breakdowns and excessive maintenance costs and other troubles," he says, "have frequently been blamed on the stoker manufacturers, whereas investigations have shown in most instances that there was nothing wrong with the apparatus, but that one or more parts had been replaced by other manufacturers or local foundries. These parts, not being properly fitted, had caused further excessive maintenance and had eventually led to breakdowns. This has often been the cause of stokers getting a bad name for unreliability due absolutely to no fault of the stoker manufacturing companies."

Some stoker companies have organized service departments and employ engineers who visit their installations once or twice a year.

Ford's Muscle Shoals Offer Now Before House—Deadlock Feared

The Military Affairs Committee of the House of Representatives, which for some weeks has been considering the various offers made for taking over the Muscle Shoals project, has reported Henry Ford's offer to the House with the recommendation that it be accepted with certain revisions.

The recommendations of a majority of the members of the committee are embodied in a bill introduced June 5 by Representative McKenzie, the acting chairman of the committee.

The bill recommends the acceptance of Mr. Ford's offer, as revised on May 31, less the steam plant at Gorgas and with certain changes in the verbiage of the fertilizer and other paragraphs.

The minority of the committee's membership favored the unqualified acceptance of Mr. Ford's offer as amended on May 31, and was to have submitted its bill and report the latter part of the week. Two other bills were also introduced, proposing the acceptance of the Ford offer; one was by Representative Wright, of Georgia, a member of the committee, but acting independently of the minority. The other was introduced by Representative Almon, of Alabama, in whose district the property is situated.

That the situation may develop into a deadlock is indicated by the fact that Mr. Ford has declined to accept the counter-proposition submitted him by the Military Affairs Committee. The committee took the original Ford offer and made amendments to it paragraph by paragraph, suggesting to Mr. Ford that it would be willing to recommend the acceptance of the offer in that form. Mr. Ford in turn did some further amending. He insisted that the steam plant at Gorgas and the transmission lines to the nitrate plant be included in the property, and altered the language dealing with the guarantee as to fertilizer production in a way that is unsatisfactory to the committee. Excerpts from his reply to the Committee are as follows:

I cannot consent to eliminate the Gorgas plant because it is necessary to the economical operation of the Muscle Shoals properties. If my revised offer for Gorgas is rejected, then I must understand that the acceptance of my offer for Muscle Shoals "as a whole and not in part" is refused.

If Congress votes acceptance of my offer, we will get on the job at Muscle Shoals at once; but if Congress rejects it, that will be but the beginning of a more determined effort on my part to save Muscle Shoals for the benefit of the public.

An offer to the War Department to purchase for $2,500,000 the Gorgas power plant and the Government's interest in the railroad and transmission line from Gorgas to Muscle Shoals has been made by the Alabama Power Co. The offer has been submitted to the Senate Agriculture Committee by the War Department, this committee having under consideration the various lease offers.

A. I. E. E. Convention at Niagara Falls—To Visit Queenston Plant

A number of important papers in the power-plant field are among those scheduled on the tentative program for the thirty-eighth annual convention of the American Institute of Electrical Engineers, which is to be held June 26-30 at Niagara Falls, Ontario, with headquarters at the Clifton Hotel. Thirty-one papers have so far been announced. They have been classified in six groups.

One group will include four papers on the Queenston hydro-electric plant, which contains the largest waterwheel units in the world, and which will be visited by those attending the convention in an afternoon set aside for the purpose. The papers to be given on the plant are as follows:

"Queenston-Chippawa Development of the Hydro-Electric Power Commission of Ontario," by F. A. Gaby, chief engineer, Hydro-Electric Power Commission of Ontario.

"Description of the 45,000-kva. Queenston Generators," by B. L. Barns, engineer, Canadian General Electric Company.

"Design of 45,000-kva. Generators, Queenston Plant," by R. A. McCarty, engineering department, Westinghouse Electric and Manufacturing Co., and H. U. Hart, general manager, Canadian Westinghouse Company.

"Features of Main Power-House Transformers for Queenston Plant," by C. A. Price, assistant chief engineer, Canadian Westinghouse Co., and M. E. Skinner, assistant to general manager, Duquesne Light Company.

Another group will be devoted to the standard of rating of class "B" insulation, and conventional allowances for generators, with the following three papers:

"Questions Relating to Standards of Rating," F. D. Newbury, power engineering department, Westinghouse Electric and Manufacturing Company.

"Probable Values of Conventional Allowance for A-C Generator Stator Windings," by F. D. Newbury.

"Temperature Limits in Large Machines," by P. Torchio, chief electrical engineer, New York Edison Company.

Another group will cover the tests made at Baltimore on oil circuit breakers. These are the highest power tests ever made on this kind of apparatus, and their results are of great importance. Papers dealing with the tests will be given by H. C. Louis, chief of tests, Consolidated Gas, Electric Light and Power Co., Baltimore, Md., and A. F. Bang, testing engineer, Pennsylvania Water and Power Co., and papers will also be given by engineers of the General Electric and the Westinghouse companies dealing with the performance of their apparatus.

The fourth group will consist of a symposium on engineering education. The six papers that will be given will take the viewpoint of the employer of college graduates. They are as follows:

"Some Suggestions Concerning the College Education of an Engineer," by Carl Hering, consulting electrical engineer, Philadelphia, Pa.

"Training for Character," by A. M. Dudley, manager, automotive engineering department, Westinghouse Electric and Manufacturing Company.

"Some Suggestions for Possible Improvements in Methods of Engineering Education," by B. G. Lamme, chief engineer, Westinghouse Electric and Manufacturing Company.

"Better Preparation of Students for Railway Work," by I. C. Forshee, electrical engineer, Pennsylvania Railroad.

"Education," by S. E. Doane, chief engineer, National Lamp Works of General Electric Company.

"Principles of Engineering Education," by P. Torchio, chief electrical engineer, New York Edison Co.

In a group of papers on miscellaneous subjects, the following are of interest to *Power* readers:

"Higher Steam Pressures or Pulverized Coal?" by F. A. Scheffler, manager of the power department, Fuller Engineering Company.

"Determination of Temperature of Electrical Apparatus and Cables in Service," by E. J. Rutan, test department, New York Edison Company.

"Transmission-Line Relay Protection," by E. A. Hester, R. N. Conwell, O. C. Traver and L. N. Crichton, of Relay Subcommittee of Protective Devices Committee.

"A Method of Determining Resultant Input from Individual Duty Cycles and of Determining Temperature Rating," by Bassett Jones, consulting engineer, New York City.

The sixth group consists of a number of papers dealing with cable insulation.

The usual athletic and social features of a convention have been arranged for and the suggestion has been made that the number of popular Canadian summer resorts near Niagara Falls will give visitors to the convention a convenient opportunity of extending their vacations. Two special entertainment features will be a musical recital by Professor Karapetoff, who is to introduce for the first time in public a new five-string cello, and a special lecture at which J. L. Harper, chief engineer of the Niagara Falls Power Company, will give the history of the development of power at Niagara and its various power plants.

The convention committee is headed by F. R. Ewart; E. E. F. Creighton is chairman of the Meetings and Papers Committee. The national headquarters of the society are 29 West 39th Street, New York City.

Planned to Supply New York City with Niagara Power

The American Superpower Corporation, which represents substantially the same interests as those that were behind the Niagara Power and Development Co., has applied to the Federal Power Commission for a preliminary permit covering the use of 12,000 cu.ft. per sec., or one-half the additional diversion of water in the Niagara River recommended by the Board of Engineers. The application was filed with the distinct understanding that no action whatever would be taken on it until after the additional diversion may have been arranged. It is thought the application was made solely for legal purposes in connection with the existing controversy between the Federal Government and the State of New York, in the matter of the Water Power Act.

The application proposes the construction of a transmission line from Lewiston, in Niagara County, to Yonkers, where connection will be made with lines supplying New York City. The estimated cost is $27,457,000. The power canal from La Salle to Lewiston is to be made available for water transportation, and in addition a waterway is to be made possible "from the upper Niagara River to the lower Niagara River, the State of New York having granted this route to applicant in order that private interests might be induced to accomplish the construction of a ship canal on the American side around Niagara Falls, for which both the State and Federal Governments have made frequent surveys but without undertaking such project."

The applicant estimates that $34,188,000 will be required for the construction of the works necessary for the generation of 450,000 hp., under a head of 301 ft. at 88 per cent efficiency. The power house would be equipped with nine units of 50,000 hp. each, to be stepped up to 110,000 volts for local distribution and to 220,000 volts for transmission to New York. The power taken from the line at intermediate points would be stepped down to the required voltage. The transmission line to New York would consist of four circuits, each capable of carrying 75,000 kw. at 220,000 volts, three-phase at 60 cycles. There would be two independent lines on a right of way 350 ft. wide.

The chief engineer of the Superpower Corporation is Frederick W. Ballard, of Cleveland. The officers and directors of the new company are as follows: E. C. Randall, of Buffalo, president; Paul T. Brady, (Westinghouse Co.) vice president; F. C. Furlow, (Otis Elevator Co.); P. W. Gardner (Otis Elevator Co.); J. B. Scovell, of Lewiston; A. M. Layton, of Buffalo.

The Caddo River Power and Irrigation Company, of Little Rock, Ark., has received authorization for a preliminary permit from the Federal Power Commission for a power project consisting of three dams and power houses to be put up on the Ouachita River, near Hot Springs, Ark. The total development will be about 50,000 hp.

American Boiler Manufacturers' Association Hold Annual Meeting

The thirty-fourth Annual Convention of the American Boiler Manufacturers' Association was held at Buckwood Inn, Shawnee-on-Delaware, Pa., June 5, 6 and 7. The meeting opened with an able address by President A. G. Pratt, of the Babcock & Wilcox Co., dealing largely with the attitude of the Federal Administration toward the trade associations and favoring co-operation along the methods outlined at the conference of trade associations called at the instance of Secretary Hoover.

Dr. M. W. Alexander, managing director of the National Industrial Conference Board, described the purposes and methods of the Board and showed some of the results of its analyses and studies dealing with labor supply, the rise and fall of wages and their comparison with the cost of living, the purchasing power of a day's work and of the currency of the principal countries.

In the evening E. C. Fisher, of the Wickes Boiler Co., presented "A Study of Thickness of Shell Plates in Return-Tubular Boilers," and R. Sanford Riley, president of the Sanford Riley Stoker Co., assisted by F. H. Daniels, Jr., under whose direction the pictures were taken, exhibited films of a stoker fire in operation. Mr. Fisher's paper will be printed in full in another issue.

On Tuesday morning E. R. Fish, representative of the Association on the Boiler Code Committee of the A. S. M. E., told of the work of that body. Charles E. Gorton, chairman of the Uniform Boiler Law Society, reported the progress of boiler legislation in several states.

Joseph F. Scott, chairman, and C. O. Myers, secretary-treasurer of the National Board of Boiler and Pressure Vessel Inspectors, told of the progress of that organization. Discussion showed a warm approval of and faith in the Board and a purpose to support it in carrying out its helpful purposes.

Mr. Pratt reported for the conference committee with the Stoker Manufacturers' Association and W. E. Connelly, of the D. Connelly Co., for the Commercial Committee. George W. Bach, of the Union Iron Works, reported for the Committee on Ethics that there had been no infraction of the Code reported during the year.

Mr. Bach in the absence of L. E. Connelly, reported for the committee appointed to investigate the Proper Setting Heights of Hand-Fired Return-Tubular Boilers, recommending minimum heights in inches as follows:

	Diameter of Shell					
	54	60	66	72	78	84
Bituminous coals containing more than 35 per cent volatile	32	36	40	44	48	52
Bituminous coals containing 18 to 35 per cent volatile	30	32	36	40	44	48
Anthracite and semi-bituminous coals containing less than 18 per cent volatile	28	28	32	36	40	44

It was further recommended that a committee be appointed to confer with a similar committee to be appointed by the Affiliated Smoke Prevention Bureaus meeting in Cleveland in the near future, with a view that co-operative action may be taken to standardize setting heights in the various districts that would meet with the approval of the boiler manufacturers and the legal authorities having this matter in charge.

On Wednesday morning Charles Aubrey Eaton, of the American Educational Association, addressed the meeting upon the broad effects of education upon citizenship, political, industrial and social relations, the satisfactory adjustment of which depends upon the creation of intelligence and right thinking rather than the accumulation of a lot of undigested knowledge.

The tentative code on Inspection of Steam Boilers now being formulated by a subcommittee of the Boiler Code Committee of the A. S. M. E., was presented for discussion and advisement by C. S. Blake, president of the Hartford Steam Boiler Inspection and Insurance Co. and chairman of the subcommittee. After a discussion of the Code in detail, which evolved several suggestions for modification, a complimentary expression of appreciation of the work of the committee was unanimously concurred in.

Votes of thanks were also passed to the International Boiler Co. for courtesies extended to members who visited its works at Stroudsburg.

The Buckwood Inn afforded excellent opportunities for entertainment between sessions, and the opportunity to play its nationally known golf course was taken advantage of by many of the members. There were several tournaments and a putting contest for the ladies. The principal item of the entertainment, otherwise, was a banquet on Tuesday evening, at which C. V. Kellogg acted as toastmaster.

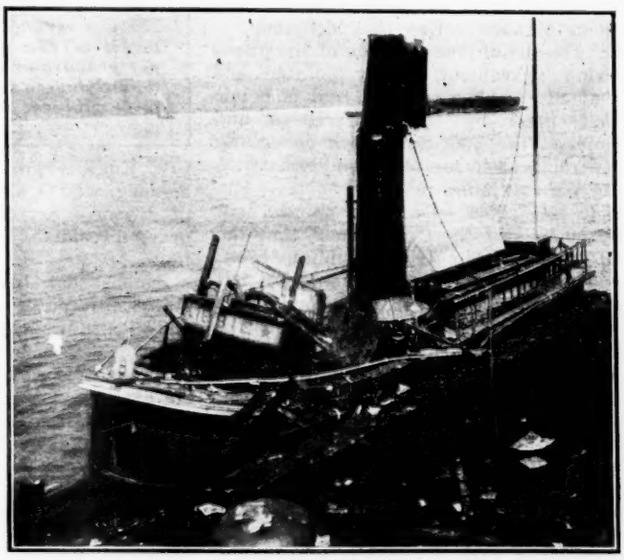
Another Bumped Head Failure

At noon on Friday, May 26, a boiler explosion occurred on the tug boat "Libby," moored in the North River, at the foot of West 58th St., New York City, seriously injuring two men and wrecking the bow of the boat.

The boiler was of the horizontal internally fired type, fitted with two furnaces. The shell was approximately 5 ft. 6 in. in diameter and about 12 ft. long and carried a steam dome 4 ft. in diameter and about 2 ft. 6 in. high. A 3½-in. safety valve of the ball-and-lever type was connected to the shell of the dome and several steam connections were also taken from it.

The head of this dome was almost completely torn away by the explosion, the tear taking place in practically a true circle at the sharp curvature where the head was flanged for riveting to the circular shell.

The ruptured dome head was of ⅜-in. plate, riveted to the shell by ¾-in. rivets spaced 2-in. centers. It was reinforced



TUG BOAT AFTER BOILER EXPLOSION, SHOWING DOME HEAD TORN FROM SHELL

by thirty stays, twenty of which were diagonal braces made of ½ x 2-in. bar iron and riveted to the head on a pitch circle 34 in. in diameter and riveted to the shell of the dome 12 in. below the flanged joint. The central portion of the head was stayed to the top of the main shell by ten vertical 1¼-in. diameter eye and pin stays.

A portion of the fracture of the dome head was rusted, showing that the initial failure was undoubtedly due to the development of a crack on the inside of the short curve of the bumped head near the flange. This crack was about 18 in. in length and at its deepest part was more than halfway through the plate.

The working pressure of the boiler was 92 lb., but no information was obtainable on the pressure carried at the time of failure. It was stated, however, by a helper on the boat that the fireman had just previously fired up and opened the draft doors in preparation for the boat leaving the dock.

News in the Field of Power

Coal Prices Steady, Conferences Continue

The steadying effect of Secretary Hoover's conference with coal operators on May 31 has continued, and there has so far been no immediate threat of a runaway market. Mr. Hoover has continued his conferences with the operators, and on June 5 met the retail dealers. He told them that he opposed the selling of coal on a basis of replacement value, contending that it should be sold at a reasonable profit above that at which it was purchased. The dealers declared that although their stocks had been rapidly decreased since the strike, they had not advanced the price.

They promised their co-operation with the Government in keeping down coal prices in the present emergency, but on the next day, June 6, representatives of the National Retail Coal Dealers' Association demanded of Senators Borah and Walsh that Secretary Hoover's maximum price of $3.50 per ton be changed or rescinded. In the absence of such action they demanded a Congressional investigation of the price-fixing agreement. They pointed out that the market price of coal is below that fixed by the conferences and charged the operators with cancelling contracts at lower rates and substituting the maximum price.

It has repeatedly been pointed out by officials of the Government that the $3.50 rate is simply a maximum limit, and that there is no reason why operators should not sell at a lower rate when they are able to do so. The price as agreed upon applies only to spot coal, and is not intended to affect existing contracts. The purpose of the agreement was to prevent a runaway market, and general opinion seems to be that it is accomplishing just that.

The opposition of the dealers to the maximum price limit is looked upon in some quarters as an effort to square themselves with the public when they take stocks, which in many cases they bought at lower prices, and sell them at prices that would be necessary if they had had to pay $3.50 a ton in the first place.

An echo of the Hoover conference was heard in the Senate when that body adopted a resolution presented by Senator Walsh of Massachusetts, calling on the Commerce Secretary for detailed information in respect to coal supplies and prices, and probable supplies and prices. Senator Frelinghuysen, however, took occasion to remind the Senate that his coal stabilization bill had been pending on the calendar for over a year, and that had it been acted on, the Senate would now have the information on which to base any action it might desire to take in connection with the strike.

Washington Meeting Promotes International Engineering Friendship

To express France's appreciation of the visit to Paris last year of the American engineering mission of thirteen, a dinner was given in Washington recently by Ambassador Jusserand to a notable group of American engineers.

The affair was held at the University Club, and Secretary of Commerce Hoover was toastmaster. The speakers were: Ambassador Jusserand; M. Aime Dumaine, representative of the Creusot Works in America and president of the American section of the Society of Civil Engineers of France; and Ambrose Swasey, who is an officer of the Legion of Honor. Secretary Hoover is honorary president of the American section.

Dr. George Otis Smith on the Hoover Coal Conference

"After attending the conference which the Secretary of Commerce has had with the coal operators, as well as living with the coal question for weeks, I am fully convinced that the plan Secretary Hoover is engineering in the interest of the public holds a larger promise of keeping coal prices down than any other move that is feasible at this time."

Ambassador Jusserand discussed the many differences between French and American engineers, saying that the great care used by the French engineer in his work is perhaps his most distinctive characteristic.

M. Dumaine, who has been actively working for closer relations between the engineers of France and America through the newly organized American section of the Society of Civil Engineers of France, said that a world union of engineers for the advancement of international peace and engineering ideals was the goal of those who had fought together on the French battlefields for the allied cause.

M. Dumaine conveyed to the engineers of America a message from M. Schneider, to whom the American mission last year awarded the John Fritz medal. The message read: "You have welded during the war the steel of Franco-American friendship. On that firm, that indestructible basis, Franco-American co-operation will erect a monument that shall not perish."

The Quartermaster Corps of the Army is asking for bids on two automatic CO_2 and draft recorders of the Uehling, Hays or similar types, for a central heating plant at Fort McPherson, Ga. The closing date is June 26.

Prominent Men To Study Smoke Problems

The possibility of drafting a standard smoke-abatement ordinance that could eventually be made universal for all classes of American cities is to be studied by a committee recently appointed by Prof. L. P. Breckenridge, of Yale University, the chairman of the Fuels Division of the American Society of Mechanical Engineers. The committee held its first meeting a few weeks ago in New York City, and decided to begin its work by formulating the basic principles underlying a fair and reasonable smoke-abatement ordinance. The committee is as follows:

O. P. Hood (chairman), mechanical engineer of the Bureau of the Mines at Washington, D. C., and Henry Kreisinger, of the Combustion Engineering Corporation, both representing the American Society of Mechanical Engineers.

P. J. Dougherty, of the International Heater Co., representing the American Society of Heating and Ventilating Engineers.

Lloyde R. Stowe, of the Lacelde-Christy Clay Products Co., representing the Stoker Manufacturers' Association.

Everett L. Millard, a Chicago lawyer, representing the American Civic Association.

Two representatives (not yet selected) of the Smoke Prevention Association and the International Railway Fuel Association.

Osborn Monnett, Chicago, Ill., a combustion engineer who has been a leader in smoke-prevention work.

Syracuse Engineers Hold Get-together Party

A jubilee dinner signalizing the affiliation of the Technology Club of Syracuse with the local sections of the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers and the American Association of Engineers was held June 1 in the Onondaga Hotel at Syracuse, N. Y.

The toastmaster was Wilbur G. Miller, president of the club, and the principal speaker was Mayor John H. Walrath, who told how it feels to be a mayor.

Bert E. Salisbury, president of the Onondaga Pottery Co., spoke briefly on "The American Valuation Plan." Dr. William P. Graham, vice chancellor of Syracuse University, spoke on "The University and the Technology Club." W. W. Wiard, president of the Syracuse Chill Plow Company, spoke on "Accurate Estimates in Factory Construction" in a talk to the consulting engineers to make the estimates high

rather than lower, if either. The Rev. Burnet T. Stafford, Episcopal rector of Jordan, spoke on "Scientific Infallibility." A provision of the club's constitution forbidding re-election of officers was suspended, and the following officers and governors were re-elected: President, Wilbur G. Miller; first vice president, Simon E. Storer; second vice president, Herman Casler of Canastota; secretary, Harold E. Bean; treasurer, Kenneth V. Farmer; governors, Guy Moulton, Oscar C. Kayle, Walter C. Pearce and E. B. Elliott.

Government Establishes Replacement Costs

The Bureau of Internal Revenue has determined ratios of estimated post-war cost of replacement for use by taxpayers in computing claims for tentative allowance for amortization. The ratios are in percentages based on prices as of June 30, 1916. Ratios for computing estimated post-war costs of replacement of machinery and equipment used in the power plant are as follows:

Electrical machinery and equipment, 130 per cent; engines, turbines, compressors and similar facilities, 175 per cent; pumps, 135 per cent; boilers, 160 per cent; transmission equipment—shafting, pulleys, hangers, etc., 135 per cent; belting 100 per cent.

New Jersey State N. A. S. E Holds Convention

The thirty-first New Jersey State convention of the National Association of Stationary Engineers, in conjunction with the mechanical exhibition of the New Jersey State Exhibitors' Association, was held at Elizabeth, June 2, 3 and 4.

There were 110 delegates present, representing the several cities in the state. The meetings of the engineers were held on the second floor of Millen's Auditorium, and the first floor was occupied by the supplymen in the display of their power-plant equipment; many new devices were shown and the exhibit was generously patronized, especially on the evenings of Friday and Saturday, when the hall was crowded to capacity. The committee deserves credit for the convenient arrangement of the booths and the taste in decoration.

On Friday evening the official opening of the exhibition took place. Past National President William J. Reynolds was the acting chairman; after a brief speech he introduced John K. English, president of the Chamber of Commerce, who told the reasons why his organization had taken such a lively interest in the convention, and complimented the N. A. S. E. on the excellence of its preamble. Eric H. Ewerts, manager of the Moore Plant of the Bethlehem Shipbuilding Co., was the next speaker, and told of the immense advancement that is constantly occurring in the engineering world. He urged upon the delegates the need of closer attention to the educational features of their organization. National Vice President Frederick Felderman closed the ceremonies by telling of the aims and objects of the N. A. S. E. and how much he regretted that the principles of the Association were not more widely known.

Water-Power Matters Before Supreme Court

Several decisions affecting the development of water power were made by the United States Supreme Court June 5, among them being one that granted the motion of the State of New York for leave to file an original bill testing the constitutionality of the Federal Water Power Act. New York contends, as told in *Power* for last week, that the Federal Government has no jurisdiction over the waters of the state except in so far as navigation is concerned.

Hydro Plants for Los Angeles

The plans of Los Angeles city to construct six large hydro-electric power plants at a cost of millions of dollars on the south and middle forks of the Kings River, in the high Sierras, were laid before the Federal Power Commission recently at its meeting in Fresno, Cal. The total power development from the project, delivered in Los Angeles, would be more than 200,000 horsepower.

Significant in the Fresno hearings was the fact that the San Joaquin Light and Power Co. also sought to secure filings on different branches of the Kings River.

Supreme Court Says Unions Can Be Sued

One of the most important decisions affecting labor unions ever handed down by the United States Supreme Court was made June 5, when that body decided unanimously that, under Sections 7 and 8 of the Sherman Anti-Trust Law, actions can be brought against unions for damages caused by their strikes, and that the funds collected by them for strike purposes can be assessed as damages. The decision thus flatly denies the stand that labor leaders have long taken—namely, that labor unions as such could not be sued, and that their strike funds could not be touched by judicial action.

The case was that of the United Mine Workers of America against the Coronado Coal Co., of Arkansas. This particular case was decided in favor of the union—the United Mine Workers of America—although the declaration of the liability of trade unions, which was a part of the decision on the case, is naturally of far greater importance than the purely local issue that was involved. The original dispute was sent back to the Arkansas courts for a new trial.

Although the basis of the decision was given as being the language of the Anti-Trust Law, the Chief Justice argued further that labor unions have gradually been given recognition and protection by the Government, and that they should therefore have appropriate responsibilities. He took the position that, in any event, the members of a union are individually liable for actions of the union as such, and that the practical difficulties in the way of bringing suit against, for instance, four hundred thousand people, make it necessary, if justice is to be obtained, to direct the suit against the union itself.

Samuel Gompers, president of the American Federation of Labor, attacked the decision bitterly and announced that organized labor will appeal to Congress and to the people to have it changed.

Obituary

Frank H. Yeager, vice chairman of the Ohio Board of Boiler Rules, died suddenly on June 4 at his home in Price Hill, Ohio. He was born 59 years ago in Cincinnati and spent 26 years in that city as engineer with the Coffin Co. He was one of the original members of the Ohio Board of Boiler Rules, having been appointed by Governor Harman in 1911. The creation of the board is considered to have been largely due to his efforts while state president of the National Association of Stationary Engineers.

George Dudley Selden, for many years and at the time of his death president of the Erie City Iron Works, died suddenly and unexpectedly June 6 at the age of 75 years. He was widely known in business circles and was prominent in his home city, having been active in welfare and religious work. He was the founder and active supporter of several philanthropic and charitable institutions, was president of the Erie Y. M. C. A. and had been the first president of the National Metal Trades Association.

Personals

Dr. E. C. Elliott, formerly chancellor of the University of Montana, has been appointed president of Purdue University.

Waldo M. Plaisted, a graduate of the engineering course of the General Electric Co., is now superintendent of the Waterbury division of the Connecticut Light and Power Co.

Erlon V. Crimmin has left the Lowell (Mass.) Electric Light Corporation, where he was electrical engineer, to join the technical department of the Edison Electric Illuminating Co., of Boston.

Eustis H. Thompson, recently engaged in special steam and electrical engineering work for the West Penn Power Co. at its Springdale and other plants, has joined the staff of *Power* as associate editor. Mr. Thompson was graduated from Cornell in 1905 and spent ten years with the General Electric Co. in the testing and construction

departments. For three years he was engaged in consulting and expert work in Baltimore, and later spent several years in steel-mill engineering and executive work. He has specialized in problems and troubles in the operation of turbines and electrical machinery.

Henry O. Pond has resigned as vice-president and managing engineer of E. B. Cadwell & Co., Inc., of New York City. At this writing Mr. Pond has not yet announced his new connection.

Clarence G. Spencer, formerly on the consulting board of the American Sugar Refining Co., has become associated with McClellan & Junkersfeld, Inc., of New York City.

P. F. Cassidy, formerly chief engineer of the Cunard Building, in New York City, has recently accepted the position of sales supervisor in the New York district for the Tide Water Oil Co. He will be remembered as the mechanical superintendent of Churchill's Restaurant on Broadway.

John F. Schurch has been elected a vice-president of Manning, Maxwell & Moore, Inc., and is taking charge of Western sales, with headquarters at Chicago. He is a graduate of the University of Minnesota and has been associated with the Minneapolis, St. Paul & Sault Ste. Marie R.R., the Railway Materials Co., of Chicago, and the T. H. Symington Co.

M. A. Pooler has been appointed general manager of the New Brunswick Power Co., with offices in St. John. He succeeds Percy W. Thomson, resigned. Mr. Pooler is a graduate of the Case School of Applied Science and of Purdue University, and for the last eight years has been general manager of the Potomac Public Service Co. He has for many years been associated with the firm of Sanderson & Porter, of New York, which is to direct the management and operations of the New Brunswick Power Company.

Business Items

The Combustion Engineering Corp., Broad St., New York City, has transferred A. D. Halporn from its Philadelphia to its New York sales force.

The Standard Water Systems Company of New Jersey, Hampton, N. J., has announced its incorporation as the successor of the Standard Water Systems Co.—the Hampton plant, patents and trade marks of which were purchased recently. The new concern will continue the manufacture of feed-water heaters, evaporators, condensers and other steam specialties together with st lls for bottlers and chemists.

The Manufacturers Electrical Corporation, 123 West Madison St., Chicago, Ill., has been incorporated as the exclusive representative in the Middle West for a number of manufacturers of electrical equipment, including circuit breakers, transformers, switching equipment, moulded insulation, and other electrical materials. Edgar Switzer has resigned as syndicate representative of the Westinghouse Co. in the Chicago territory to become vice-president and general manager of the new corporation.

Buell, Scheib, Mueller, Inc., is a new firm that has been formed by W. C. Buell, Jr., Walter H. Scheib and Edward O. Mueller, as consulting and combustion engineers, specializing in fuel economy and furnace design. Offices have been taken in the Columbia Bank Building, Pittsburgh, Pa.

Quigley Fuel Systems, Inc., 26 Cortlandt St., New York City, has been organized to carry on the work formerly conducted by the Quigley Fuel Systems Department of the Hardinge Co., Inc. The new company is entirely independent of the Hardinge Co. The officers are: William H. Baker, president; W. O. Renkin, managing engineer; L. W. Marso, Pittsburgh representative.

Society Affairs

Coming Conventions

Stoker Manufacturers' Association; J. G. Worker, Eau Claire, Wis. Semiannual meeting at Groton Point, Conn., June 19-21.

National District Heating Association; D. L. Gaskill, Greenville, Ohio. Annual convention at Cedar Point, Ohio, June 20-23.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Annual convention at Niagara Falls, Ont., June 26-30.

American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 26-July 1.

Canadian Association of Stationary Engineers; G. C. Keith, 51 Wellington St. West, Toronto, Ont. Annual convention and exhibition at Kitchener, Ontario, June 27-29.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual conventions and exhibitions of the State Associations scheduled as follows:

Connecticut, at New Haven, June 23-24; Fred C. Sutorius, 890 Chapel St., New Haven.

New England, at Springfield, Mass., July 12-14; James Morgan, 53 Devonshire St., Boston.

Michigan, at Kalamazoo, July 19-21; A. M. Adams, 1307 Stockbridge Ave., Kalamazoo, Mich.

Trade Catalogs

Small Steam Turbines—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin No. 1123, explaining the construction of turbines for driving condenser auxiliaries, exciters, small generators, etc.

Steam Turbines—London Steam Turbine Co., (successor to the Steam Motors Co.) P.O. Box 436, Troy, N. Y. Bulletin 14, 28 pages. Simplicity and convenience instantly attract attention. The requirements of small turbine drives are so squarely met and the possibilities so well utilized that much satisfaction is derived from reading this new catalog. Aside from the clear-cut description and illustrations, it is worth while to review the principles of construction which counteract alignment troubles, eliminate unnecessary bearings and make for safe and stable operation. The design of the self-aligning ball bearing and double-vane labyrinth packing, as well as other features, appeal directly to the engineer and reflect the substantial experience and skill of the manufacturer.

Superheaters—The Superheater Co., 17 East 42d St., New York City. Bulletin T-1 will be appreciated by power engineers who want to know more about the reasons for using superheated steam, since considerable space is given to a discussion of that subject, in addition to a description of the company's improved superheater.

Lubrication of Diesel Engines—Vacuum Oil Co., 61 Broadway, New York City. A splendidly prepared 32-page booklet that explains in general the principles of operation of the Diesel engine and then goes into great detail, with colored illustrations, to show the methods of lubrication used with such engines. A booklet that ranks high in educational value.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	May 29, 1922	June 5, 1922
Pool 1,	New York	.....	$4.00–4.75
Smokeless,	Columbus	$3.25–3.50	2.75–3.25
Clearfield,	Boston	3.00–3.25	3.00–3.40
Somerset,	Boston	3.25–3.50	2.90–3.40
Kanawha,	Columbus	3.15–3.35	2.75–3.00
Hocking,	Columbus	3.50–3.60	2.85–3.20
Pittsburgh No. 8	Cleveland	3.00–3.50	.....
Franklin, Ill.,	Chicago	.....	.....
Central, Ill.,	Chicago	.....	.....
Ind. 4th Vein,	Chicago	.....	.....
West Ky.,	Louisville	3.10–3.35	3.20–3.40
Big Seam,	Birmingham	.....	1.50–1.90
S. E. Ky.,	Louisville	3.00–3.25	2.50–3.25

FUEL OIL

New York—June 8, Port Arthur light oil 22@25 deg. Baumé 3⅛c. per gal.; 30@35 deg., 4¾c. per gal., f.o.b Bayonne, N. J.

Chicago—May 20, for 24@28 deg. Baumé, 85@90c. per bbl.; 21@36 deg., 2⅞@2½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted to conform.

Pittsburgh—June 7, f.o.b. refinery, Pennsylvania, 36@40 deg. 5c.; Kentucky fuel oil, 26@30 deg., 3½c. per gal. Gas. oil, 32@34 deg., 3c. per gal.; 36@38 deg., 3¼c.; 38@40 deg., 3½c. Western. 24@30 deg., 85c. per bbl.

St. Louis—June 8, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 90c per bbl.; 26@28 deg., 95c.; 28@30 deg., $1.10; 32@34 deg. 2⅞c. per gal.

Philadelphia—June 5, 26@28 deg. Baumé, Oklahoma, 70@80c. per bbl.; 30@34 deg., Oklahoma (group 3), 3½@3¼c. per gal.; 16@20 deg. Seaboard, $1.10@$1.25 per bbl.

Cincinnati—May 27, for 26@30 deg. Baumé, 5½c.; Diesel 32@34 deg., 5¼c per gal.; distillate 39@40 deg., 6c.

Cleveland—May 27, 26@30 deg. Baumé, 4¼c. per gal.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Advances—Steel shapes quoted at $2.68 as against $2.58 per 100 lb., delivered, New York. Air hose, ¾-in., up 3c.@7c. per ft. Cement higher in New York. White and red lead, both dry and in oil, advanced ½c. per lb. Boiler rivets quoted at $2.35, Pittsburgh mill, as against $2.20@$2.35 per 100 lb., last month. Babbitt metal up 5c. in New York and 2½c. per lb. in Cleveland warehouses.

Declines—Fire hose, 2½-in., down 2½c. per ft. Tendency of linseed oil market, downward. Raw oil quoted at 88c. as compared with 91c. per gal., 5 bbl. lots, f.o.b. New York, one month ago.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled		47c. per ft.
Common, 2½-in., 3-ply		1.00 per ft. list less 50%

	Air	
	First Grade	Second Grade
¾-in., 3-ply, per ft.	$0.31	$0.22½

Steam—Discounts from List

First grade....40–10% Second grade...50–5% Third grade....50–10–5%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 60–10–5% Best grade..... .... 60–5%

LEATHER BELTING—List price per ply, 12-in. wide, per lin. ft. $2.88

Grade	Discount from list
Medium	40–5%
Heavy	35%

RAWHIDE LACING—For cut, best grade, 50–10%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 39c. Semi-tanned: cut, 50%; sides, 43c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.80
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		60% off
For low-pressure heating and return lines	4-ply	70% off
	3-ply	72% off
	2-ply	74% off

PORTLAND CEMENT—New York, $2.40@$2.50 per bbl. without bags, in cargo lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $2.68 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	7.50@10.00	12.00	12.00
Mixed	5.50@ 9.00	9.00	9.00

WIPING CLOTHS—Jobbers' price per 1,000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$50.00	$55.00
Chicago	55.00	65.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.88	$0.95	$0.98

WHITE AND RED LEAD—Base price per pound:

	Red				White			
	Current		1 Year Ago		Current		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil		
100-lb. keg	12.50	14.00	13.00	14.50	12.50	13.00		
25- and 50-lb. keg.	12.75	14.25	13.25	14.75	12.75	13.25		
12½-lb. keg	13.00	14.50	13.50	15.00	13.00	13.50		
5-lb. cans	15.50	17.00	16.00	17.50	15.50	16.00		
1-lb. cans	17.50	19.00	18.00	19.50	17.50	18.00		

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	60–10%	70%	60–10%
Tinned	60–10%	70%	4½c. per lb. net

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York.....$3.50 Chicago.....$3.10 Pittsburgh.....$2.25

Boiler rivets, same sizes:

New York.....$3.60 Chicago.....$3.20 Pittsburgh.....$2.35

REFRACTORIES—Prices in carlots:

Chrome brick, eastern shipping points	net ton	$42@45
Chrome cement, 40@45% Cr_2O_3	net ton	27@30
Chrome cement, 40@45% Cr_2O_3, in sacks	net ton	29.50@31.50
Magnesite brick: 9-in. straight	net ton	53@55
Magnesite brick: 9-in. arches, wedges and keys	net ton	58.30@60.50
Magnesite brick: Soaps and spits	per ton	74@77
Silica brick: Chicago district	per 1,000	35@38
Silica brick: Birmingham, Ala	per 1,000	40.00
Silica brick: Mt. Union, Pa	per 1,000	30@33
Chrome ore crude, 45@50%	net ton	20@22
Magnesite dead burn (Imported)	net ton	28@30
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per 1000	32@35
Clay brick, 1st quality, 9 in. shapes, Ohio	per 1000	32@35
Clay brick, 1st quality, 9 in. shapes, Kentucky	per 1000	32@35
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per 1,000	28@32
Clay brick, 2nd quality, 9 in. shapes, Ohio	per 1,000	28@32
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per 1,000	28@32

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
Fair grade	35.00	42.00	36.00
Commercial	15.50	16.00	9.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting and screw stock, per 100 lb. base	$3.35	$3.30	$3.00
Flats, square and hexagons, per 100 lb. base	3.85	3.80	3.50

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	60%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
1 to 3	71	58½	¼ to 1½	44½	29½

LAP WELD

2	64	51½	2	39½	25½
2½ to 6	68	55½	2½ to 4	42½	29½
7 to 8	65	51½	4½ to 6	42½	29½
9 and 12	64	50½	7 to 12	40½	27½

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	69	57½	¼ to 1½	44½	30½
2 to 3	70	58½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	62	50½	2	40½	27½
2½ to 4	66	54½	2½ to 4	43½	31½
4½ to 6	65	53½	4½ to 6	42½	30½
7 to 8	61	47½	7 to 8	35½	23½
9 to 12	55	41½	9 to 12	30½	18½

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	.15
1¼	.....	.....	.1650
1½	.....	.....	.1411
1¾	$0.1654	$0.1881	.1530
2	.1305	.1607	.1332
2¼	.1491	.1836	.1521
2½	.1566	.2160	.1824
2¾	.....	.....	.....
3	.1916	.2668	.2097
3¼	.2066	.3078	.2253
3½	.2204	.3282	.2403
4	.2800	.4173	.3054

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2¼ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 44.00 (net)	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

Less than coil lots	30%	10%
Coils to 1,000 ft.	40%	20%
1,000 to 5,000 ft.	41%	22%
5,000 ft. and over	43%	25%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York, with 10-day discount of 5 per cent.

Size, In.	Conduit Black	Conduit Galvanized	Elbows Black	Elbows Galvanized	Couplings Black	Couplings Galvanized
¼	46.58	51.68	9.65	10.97	4.75	5.17
⅜	59.57	66.47	12.70	14.20	6.78	7.38
½	84.66	94.86	12.80	21.02	8.81	9.59
¾	114.54	128.34	25.11	27.81	12.38	13.40
1	136.95	153.45	33.48	37.08	15.29	16.55
1¼	184.26	206.46	61.38	67.98	20.38	22.06
1½	291.33	326.43	100.44	111.24	29.12	31.52
2	380.97	426.87	267.84	296.64	43.68	47.28
2½	485.76	540.96	591.48	655.08	58.24	63.04
3	597.32	662.72	683.55	757.05	72.80	78.80

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.08	D. P. D. B.	$0.26
D. P. M. L.	.13	T. P. S. B.	.25
T. P. M. L.	.19	T. P. D. B.	.38
D. P. S. B.	.15		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.38	$1.20	$1.25
T. P. M. L.	.53	1.40	1.80
D. P. S. B.	.47	1.20	.....
T. P. S. B.	.88	2.00	.....
D. P. D. B.	.85	2.35	.....
T. P. D. B.	1.50	4.00	.....
T. P. to D. P. D. B.	1.00	2.75	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	19.00
No. 16 cotton reinforced heavy	24.90
No. 18 cotton reinforced light	16.50
No. 16 cotton reinforced light	20.50
No. 18 cotton Canvasite cord	14.00
No. 16 cotton Canvasite cord	16.25

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$.20	3-amp. to 30-amp.,	100	$0.40
35-amp. to 60-amp.,	100	0 30	35-amp. to 60-amp.,	100	.60
65-amp. to 100-amp.,	50	2.90	65-amp. to 100-amp.,	50	1.50
110-amp. to 200-amp.,	25	.00	110-amp. to 200-amp.,	25	2.50
225-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
425-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 60–5%; standard package, 65–5%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package	$2.40
0–30 ampere, less than standard package	2.75

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.40	100	75	$0.70	$0.75	50
15	.35	.40	100	100	.95	1.00	24
25	.35	.40	100	150	1.30	1.40	24
40	.35	.40	100	200	1.80	1.90	24
50	.35	.40	100	300	2.50	2.65	24
60	.40	.45	100				12
				500	3.75	3.95	12
				750	5.25	5.50	8
				1.000	6.00	6.35	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.17
Composition 2-piece attachment plug	.24
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 6.25	$ 8.00	$ 9.55	$15.20
12	8.30	10.10	11.95	19.85
10	10.90	13.00	15.20	25.80
8	14.65	17.05	20.05	34.50
6	.....	.....	30.30	.....
4	.....	.....	40.90	.....
2	.....	.....	61.90	.....
1	.....	.....	82.70	.....
0	.....	.....	102.65	.....
00	.....	.....	121.80	.....
000	.....	.....	146.35	.....
0000	.....	.....	175.15	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	¼ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	15%
1-5th to standard package	30%
Standard package	45%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	21c. lb
Soldering paste, 2 oz. cans	$1.00 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:	
Less than $10.00 list value	5%
$10 to $25 list value	20%
$25 to $50 list value	25%
$50 to $200 list value	35%
$200 list value or over	40%

New Plant Construction

PROPOSED WORK

Cal.—The Hurley Machine Co., E. H. Hurley, Pres., West 22d and South 54th Aves., Cicero, Ill., plans to build an electrical plant on the Pacific coast. Estimated cost $1,000,000. Site not selected.

Cal., Sacramento—The city is having surveys made for municipal hydro-electric system, including 2 dams, No. 1, 210 ft. high and 900 ft. long, No. 2, 110 ft. high and 380 ft. long, and 2 power houses. If project is found feasible election will be called to vote $7,500,000 bonds. A. Givan, City Hall, Engr.

Cal., San Diego—The Sidney E. Mayer Co., S. E. Mayer, Purch. Agt., 330 Fifth St., is in the market for vertical boiler, 50 hp., 100 lbs. pressure.

Cal., San Francisco—A. F. Rousseau, 110 Sutter St., is having plans prepared for a 10 story theater and hotel on Market St. Estimated cost $1,250,000. Meyer & Johnson, Bankers Investment Bldg., Archts.

Cal., San Francisco—The Scottish Rite A. & A.S.B., Sutter and Van Ness Sts. plans to build a cathedral. Estimated cost $1,000,000. Weeks & Day, Phelan Bldg., Archts.

Cal., Santa Rosa—The High School district has voted $375,000 bonds for school building. Architect not selected.

D. C., Wash.—Dist. Comrs., 509 Dist. Bldg., received bids for the construction, including mechanical equipment and radial brick stack, of a power house at the Gallinger Hospital, 19th St. and Massachusetts Ave., S. E., from, M. B. Casey, 3207 14th St., N. W., $105,044; Federal Heating Co., 310 13th St., $108,215; Standard Eng. Co., 2129 I St., N. W., $112,500.

D. C., Wash.—The War Dept. c/o Col. N. E. Wood, 2329 Munitions Bldg., 19th and B Sts., will receive bids until June 26, for a 3 story Army Medical School, including heating and ventilating systems at the Walter Reed Hospital. Noted December 27.

Fla., Homestead—The town council will receive bids until about July 10th for 300 kw., 3 phase, 60 cycle electric light plant. Estimated cost $50,000. B. M. Duncan, Engr.

Fla., Jacksonville—H. W. Dexter, 16th St., is in the market for one 30 hp. single hoisting engine; two 30 hp. double drum hoists with drum boilers; one 650 kw., 240 volt d.c. generator, belt driven.

Fla., Lakeland—The Non-Acid Fertilizer & Chemical Co., H. E. Meminger, Mgr., is having plans prepared for fertilizer plant. H. D. Mendenhall, Archt. Quotations wanted on machinery and equipment, including engines, boilers, dryers, tanks, etc.

Fla., Winter Garden—The city, S. C. Carmack, Clk., will receive bids until June 15, for two 500 gal. per minute, 250 ft. head vertical pumps with 50 hp. motors and centrifugal pumps, including hydraulic connections, foundations, electrical auxiliaries, pipe, etc.

Ill., Chicago—The Albert Hotel & Building Corp., c/o W. W. Ahlschlager, Archt., 65 East Huron St., is preparing plans for 10 story, 137 x 150 ft. addition to hotel, including steam heating system, on Kenmore and Granville Sts. Estimated cost $1,500,000.

Ill., Chicago—B. Heller & Co., 3925 Calumet Ave., is in the market for a 100 hp., synchronous, 220 volt, a.c., 3 phase 60 cycle, 720 R.P.M. motor and a number of 10-30 hp. motors.

Ill., Chicago—The National Automobile Hotel Co., c/o Glaver & Dinkelberg, Archts., 400 North Michigan St., will soon award the contract for 21 story, 72 x 140 ft. motor hotel and garage, including steam heating system on Wabash Ave. and Lake St. Estimated cost $1,200,000.

Ill., Chicago—S. H. Newman, c/o W. W. Ahlschlager, Archt., 65 East Huron St., is having plans prepared for 6 story, 33 x 70 ft. apartment, including steam heating system on Albion Ave., near Sheridan Rd. Estimated cost $900,000.

Ill., Chicago—Roberts & Oakes, 141 West Jackson Blvd., plan to build a packing plant on Racine Ave. and 45th St. Estimated cost $500,000.

Ill., Chicago—The Theological Seminary, c/o H. H. Riddle, Archt., 122 South Michigan Ave., is having plans prepared for 4 story dormitory including steam heating system on 58th St. Estimated cost $500,000.

Ill., Evanston—The Main Street Building Corp., c/o J. N. Nyder Archt., 190 North State St., Chicago, is having plans prepared for 5 story, 60 x 175 ft. stores and hotel, including steam heating system, on Main St. and Hinman Ave. Estimated cost $350,000.

Ill., Maywood—Pieneir & Rosegarden, 421 Lake St. are in the market for 40 to 50 hp. tubular steam boiler.

Ind., Crown Point—The Bd. Comrs. of Lake County having revised plans prepared for two 2 story, 75 x 125 and 70 x 115 ft. hospital buildings. Estimated cost $300,000. Former bids rejected. N. L. Smith, Archt. Noted Feb. 7.

Ind., Evansville—Treasury Dept., J. A. Wetmore, Superv. Archt., Wash., D. C., will receive bids until June 23 removing 2 boilers, etc., and furnishing and installing 2 new horizoztal return tubular high pressure steam boilers, with down draft furnaces, at the U. S. Marine Hospital, here.

Ind., Kokomo—The Kokomo Gas & Fuel Co., c/o C. A. Monroe, Pres., is having plans prepared for gas manufacturing plant. Estimated cost $500,000. The Kopper Co., Union Arcade Bldg., Pittsburgh, Pa., Engrs.

Kan., Girard—W. H. Wayland is in the market for an automatic air outfit, tank, pump, belt and motor.

Kan., Wichita—The Secretary Bd. Educ. will receive bids until June 22 for 3 story high school on East Douglas St. Estimated cost $1,000,000. L. Schmidt & Co., 121 North Market St., Archts.

La., Monroe—The Arkansas, Louisiana & Texas Development Co., c/o W. L. McCloy, Pres., Tulsa, Okla., soon receives bids for the construction of 250 mi. pipe line from here to Pt. Arthur, Tex., refineries. Is open for quotations on 3 steam compressor stations of about 325 lbs. pressure each. J. M. Dutton, Tex., c/o owner, Engr.

La., New Orleans—W. W. Carre Co., Ltd., 317 Baronne St., is in the market for 1 direct connected generator about 300-400 kw., 440 volts, 60 cycle and 3 phase.

Maine, Portland — The Confederated Home Abbatoir Corp. plans to build meat packing plant, also ice manufacturing and refrigeration plant. Estimated cost $500,000. Architect not announced.

Md., Baltimore—Treasury Dept., J. A. Wetmore, Superv. Archt., Wash., D. C., will receive bids until June 19 for a steam heating system at the U. S. Quarantine Station, here.

Mass., Beverly—The Bd. Educ., H. A. McDonald, Chn., is having plans prepared for 3 story high school on Sawyer Rd. Estimated cost $750,000. Adden & Parker, 177 State St., Boston, Archts. Noted May 31, 1921.

Mass., Medford—The Bd. Educ. is having plans prepared for 3 story high school. Estimated cost $300,000. J. D. Leland Co., 41 Mt. Vernon St., Boston, Archts.

Mich., Houghton—The Bd. Educ., W. F. Miller, Secy., is having plans prepared for 2 story high and grade school. Estimated cost $400,000. Van Leyen, Schilling, Keough & Reynolds, 3440 Cass Ave., Detroit, Archts. Excavation contract has been awarded.

Mich., St. Joseph—Whitcomb Hotel is having specifications made for new boilers and probably a new electrical generating plant. Cahill & Douglas, 217 West Water St., Milwaukee, Wis., Engrs.

Minn., Edgerton—The city plans improvements to water-works, including 25,000 or 30,000 gal. capacity tank, pumphouse, pumps, etc. Architect not selected.

Mo., Kansas City—Midwest Auto Supply Co., 416 East 15th St., is in the market for an automatic air outfit, pump, motor and air tank.

Mo., Kansas City—J. Wolff, 3100 East 20th St., is in the market for a 4 cylinder, 12 hp. marine engine.

N. H., Concord—The Utilities Power Co. plans to construct hydro electric power plant and dam on Pemigewassett River. Estimated cost $1,000,000. Engineer not announced.

N. Y., Buffalo—The Genesee Properties, Inc., S. Weed, 95 Swann St., Judge L. B. Hart, N. P. Clement, 290 Linwood Ave., directors, plan to build 14 story store and office building on Main and Genesee Sts. Estimated cost $2,000,000.

N. Y., Clyde—A. D. Collier and other citizens plan to build a cold storage plant, 60,000 bbls. capacity. Estimated cost $180,000 to $200,000.

N. Y., Dunkirk—The taxpayers defeated $1,400,000 bond issue for gravity water system in Arkwright Hills, south of here. Noted May 9.

N. Y., Jamestown—The Bd. Educ. is having plans prepared for 2 junior high schools. Estimated cost $750,000. Betelle & Guilbert, 546 Broad St., Newark, N. J., Archts. Ford & Johnson, Assd. Archts.

N. Y., New York—The Bendheim Construction Co., c/o Schwartz & Gross, Archts., 347 Fifth Ave., is having plans prepared for 9 story, 125 x 15 ft. apartment, including steam heating system on 52nd St. About $1,000,000.

N. Y., New York—The Bd. Educ., 500 Park Ave., plans to build 200 x 228 ft. addition to Theodore Roosevelt high school, including steam heating system, on Walton and Gerard Aves. C. B. J. Snyder, Concord St., Brooklyn, Archt. and Engr.

N. Y., New York—The Dept. Parks, Municipal Bldg., rejected bids received May 25 for ice making plant in the American Museum of Natural History, 77th St. and Central Park West. Bids will be readvertised. Noted May 23.

N. Y., New York—M. B. Jennings, c/o J. E. R. Carpenter, Archt. and Engr., 598 Madison Ave., will build 14 story, 100 x 150 ft. apartment, including steam heating system on 36th St. and 5th Ave. Estimated cost $700,000. Work will be done by separate contract under supervision of architect.

N. Y., New York—The New York Tribune, 154 Nassau St., will soon award contract for 7 story office building on 219 West 40th St. About $500,000. Lockwood, Green & Co., 101 Park Ave., Archts. and Engrs.

N. Y., New York — The 114 East 52 St. Corp., c/o G. F. Pelham, Archt. and Engr., 200 West 72 St., is having plans prepared for 15 story, 88 x 90 ft. hotel, including steam heating system, on 114-120 East 52nd St. Estimated cost $750,000.

N. Y., Niagara Falls—E. Beir and L. Rosenbloom, Falls St., plan to build hotel on First St. and Jefferson Ave. Estimated cost $1,000,000. Architect not announced.

N. Y., Olean—E. Weston is in the market for locomotive type boiler, about 25 hp., for drilling operations. Oil and gas.

N. Y., Perrysburg—The Comn. Parks and Buildings, Room 6, Municipal Bldg., Buffalo, will soon award the contract for power house and tunnels, heating system, sewerage disposal plant, etc., in connection with hospital here.

N. C., Charlotte—The Citizens' Hotel Co., W. L. Stoddart, Archt. and Engr., 9 East 40th St., New York, will receive bids until about June 30 for 12 story hotel on West Trade St. Estimated cost $1,000,000.

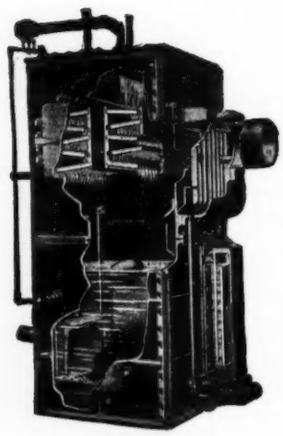
Ohio—The Army and Navy Union, c/o E. Jeffrey, National Commander, 1403 West 3d St., is having preliminary plans prepared for 1, 2 and 3 story widows and orphans home, including hospital, administration, officers quarters, gymnasium, academic school, library, church, 24 cottages, power house, work shop and farm buildings. Estimated cost $5,000,000. H. L. Porter 1900 Euclid Ave., Cleveland, Archt. E. McGeorge and A. J. Simon, 1900 Euclid Ave., Engrs. Site not selected.

Ohio, Columbus—The county, R. W. Smith, Clk., will soon receive bids for water tower and tank, electric pump and motor, in Prairie District No. 1. Estimated cost $28,000. E. L. Bradbury, 174 East Long St., Engr.

Ohio, Mt. Vernon—Bd. of Educ., L. C. White, Clk., is having plans prepared for a 2 story high school. Estimated cost $375,000. T. B. McLaughlin, Savings Bldg., Lima, Archt.

Read This Letter

Showing How COCHRANE HEATERS Save Fuel



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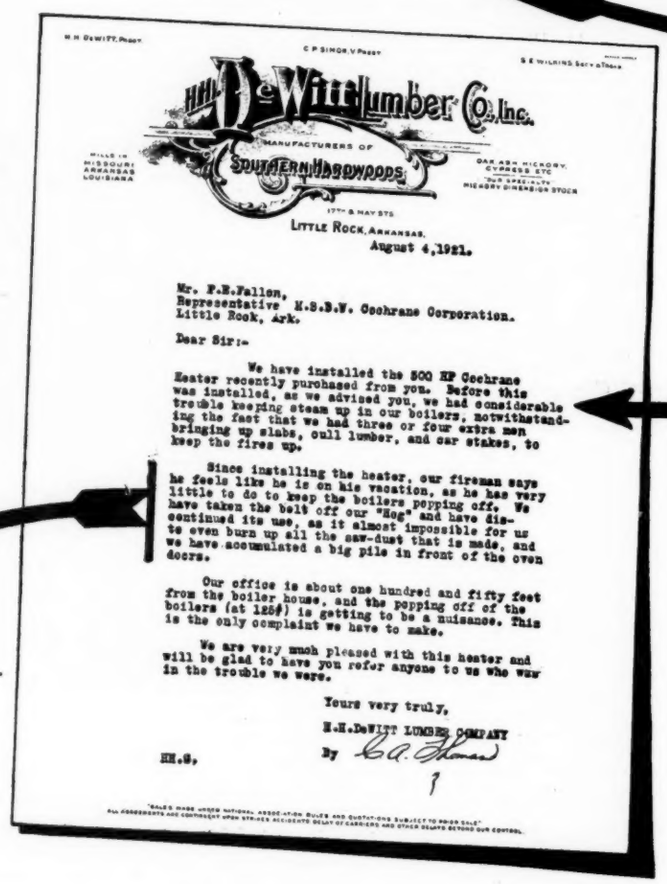

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LITTLE ROCK, ARKANSAS.

August 4,1921.

Mr. F.E.Fallon,
Representative H.S.B.W. Cochrane Corporation.
Little Rock, Ark.

Dear Sir:-

We have installed the 500 HP Cochrane Heater recently purchased from you. Before this was installed, as we advised you, we had considerable trouble keeping steam up in our boilers, notwithstanding the fact that we had three or four extra men bringing up slabs, cull lumber, and car stakes, to keep the fires up.

Since installing the heater, our fireman says he feels like he is on his vacation, as he has very little to do to keep the boilers popping off. We have taken the belt off our "Hog" and have discontinued its use, as it almost impossible for us to even burn up all the saw-dust that is made, and we have accumulated a big pile in front of the oven doors.

Our office is about one hundred and fifty feet from the boiler house, and the popping off of the boilers (at 125#) is getting to be a nuisance. This is the only complaint we have to make.

We are very much pleased with this heater and will be glad to have you refer anyone to us who was in the trouble we were.

Yours very truly,

H.H.DeWITT LUMBER COMPANY

By G.A. Thomas

HH.S.

"SALES MADE UNDER NATIONAL ASSOCIATION RULES AND QUOTATIONS SUBJECT TO PRIOR SALE"
ALL AGREEMENTS AND CONTRACTS UPON STRIKES ACCIDENTS DELAY OF CARRIERS AND OTHER DELAYS BEYOND OUR CONTROL.

"To Economize—
Cochranize"

Since installing the heater, our fireman says he feels like he is on his vacation, as he has very little to do to keep the boilers popping off. We have taken the belt off our "Hog" and have discontinued its use, as it almost impossible for us to even burn up all the saw-dust that is made, and we have accumulated a big pile in front of the oven doors.

IF FEED water enters your boilers at a temperature below 212° F., you can probably save fuel and labor just as did the DeWitt Lumber Company. Our Engineering Department would be glad to discuss this with you.

Would you be interested in any of our special treatises on heating feed water, softening water, metering water, utilizing exhaust steam, etc.?

H.S.B.W.-COCHRANE CORPORATION

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